THURSDAY, DECEMBER 22, 1887.

THE STAR OF BETHLEHEM.

THE fact that a little more than a month ago the planet Venus arrived at its maximum brilliancy when to the west of the sun, and therefore when the planet rises before the sun, has given rise to a flood of superstitious fears in this country, only to be equalled in modern times by that which the members of the Eclipse Expedition observed in Grenada last year, and chronicled in these columns, as having been met with among the semi-civilized inhabitants of that island.

In spite of School Boards and all the present stock-in-trade of elementary education, perhaps partly because that elementary education deals so little with natural science; and because before School Boards so many children scarcely went to school at all, the planet Venus, one of the most stable and the most brilliant member of the solar system, is being regarded as a second appearance of the star of Bethlehem!

This being the idea which ignorance has conjured up, superstition next comes in to bear her part, and hence very naturally all sorts of woe and desolations, the end of this world being naturally included among them, have been predicted, and in some places a considerable amount of alarm has really arisen. Nor is this all: thousands of people who ought to be able to look up pocket-books and almanacs for themselves have been for the last month pestering everybody who is known to possess a telescope for information on the subject.

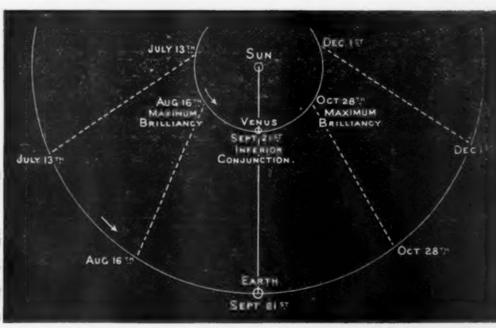
We think it, therefore, worth while to refer to this subject, for we have in this ignorant fright an additional reason, which it may be worth while to dwell upon, why the young population of a country like England should not be allowed to grow up without some knowledge, however slight, of the natural phenomena which are always being unfolded around them—phenomena which will always delight, instruct, and interest them if understood, but which will be apt to cause alarm so long as they are shrouded in mystery.

As before stated, the brilliant body in the east which is the innocent cause of all the alarm is nothing but the planet Venus near that position in her orbit in which she can send the greatest amount of light towards us.

If our youngest reader will place a candle in the middle of a table, and support a little ball some six or eight inches away from the candle, on the same level, and then retire some little distance away, to represent a spectator on the earth, the reason why Venus sometimes appears to the right or to the west of the sun and at other times to the east or left of it will be at once clear to him, if the ball be imagined to go round the candle in a direction contrary to that of the hands of a watch. Further, the fact that when the ball is on the other side of the candle it is further away, and therefore appears smaller than it is when exactly between the candle and the spectator, will give a reason why in neither of these cases will the maximum brilliancy be observed, because in one case the planet is as far away as it can be, and in the other, though the planet is as near to us as it can be, it has its dark side turned towards us; for it must be clearly understood that Venus, like the earth, receives its light from the sun, represented in our experiment by the candle; and when the spectator is on one side of the little ball, representing Venus, and the candle is on the other, naturally the non-illuminated side of the ball alone is turned towards the spectator. The period of maximum brilliancy will be when the planet is to the right or left of a line adjoining the spectator and the candle, and nearer the observer than the candle is. When the planet is to the right of this line, and therefore to the westward of it, speaking celestially, the planet must set before the sun, and therefore rise before the sun: it will be a morning star. On the other hand, when to the left of it, it must set after the sun, and therefore it will be visible as an evening star; and because it sets after the sun it will rise after it, and therefore be invisible as a morning star on account of the overpowering light of the sun. We might apologize to the readers of NATURE for referring to such elementary astronomy as this, were it not quite possible that many of them will have an opportunity, if the scare continues, of showing several young minds how to make the experiment for themselves.

The accompanying diagram will show the positions of Venus and the earth for the last few months, and will

Venus as "Evening Star."



Venus as "Morning Star."

Diagram showing the paths of the Earth and Venus from July 13 to December 1, 1887, with the points of maximum brilliancy on August 16 and October 28. Synodic period of Venus, 583·92 mean solar days.

indicate why it was at its brightest *as a morning star*, on October 28, and *as an evening star* on August 16.

It will be in the memory of some of our readers that on the appearance of the new star observed by Tycho Brahe in 1572 the general opinion was that that also was the star of Bethlehem returned. It mattered little to the vulgar that the latter was called "the star in the East," and that the new star was nearly in the zenith, and at about the same time of the year (November).

A reference to Grant's admirable history of physical astronomy will show us that such new stars were also recorded in 130, 390, 945, and 1264. The authority for these statements is Cyprian Leowitz, whose work was published in 1573. Although his statements have been discredited, there is nothing improbable in them. The "new star" of which we have heard the most, because there was a man living who was capable of chronicling and more or less understanding the phenomenon, was that to which we have referred above as having appeared in the year 1572. This was carefully watched by Tycho

Brahe. It suddenly appeared brighter than any of the stars, and brighter than Jupiter, though not brighter than Venus. This star remained visible for nearly two years. Its colour changed as it grew dimmer: first it was white, then yellow, then red, and finally, according to the record, exhibited a leaden hue like the planet Saturn. Tycho Brahe imagined it generated from the ethereal substance of which he held the Milky Way to be composed, and when it disappeared it was thought to have dissolved spontaneously from some internal cause.

It is not a gratifying thing to find, when we come to inquire further into the state of public feeling at the time when Tycho's star appeared, that after all we have advanced very little beyond the sixteenth century in matters relating to superstition. The world was to end in 1532, according to Simon Goulart, because a mountain in Assyria had been seen to open, and exposed to the gaze of those present a scroll with letters written in Greek stating that the end of the world was at hand.

Goulart was followed by a famous astrologer, Leovitius, who put on the date to 1584; and Gayon reports that the fright at that time was almost universal, and the churches would not hold those who sought shelter in them.

This end of the world mania was not confined to the unlearned, for a famous mathematician, Stoffler, who was actually engaged on the reform of the calendar undertaken by the Council of Constance, put down the end for February 1524. According to him, the end was to be by water and not by fire, and the basis of his prediction was that Saturn, Jupiter, and Mars would then be together in the sign Pisces. It was a rare time for the boat-builders, for many "arks" were built; a doctor of Toulouse, named Auriol, making himself immortal by building the biggest.

Stoffler and Regiomontanus were not, however, discouraged by the fact that not a drop of rain fell during the whole of that month in Central Europe: they merely put the date on to 1588.

It must be remembered that in those days of unusual superstition these predictions were carried broadcast through the land, and it was the consternation of the ignorant which caused everybody to believe that Tycho's star, which appeared in 1572, was really the star of Bethlehem, returned to announce the second coming of Christ.

But as a matter of fact this star of Tycho's is really connected with the present excitement, and again the idea of the return of the star of Bethlehem has been associated with it—although the year 1572 passed off quite quietly, and the planet still survives—for the following reasons. The star appeared between the constellations of Cassiopeiæ and Cepheus—that is, in the same part of the heavens in which in former times, in 945 and 1264, similar appearances had been recorded. Argelander, who inquired into the matter, found a $10\frac{1}{2}$-magnitude star catalogued by D'Arrest, but seen some years before, when the same part of the heavens (R.A. 4h. 19m. 58s., Decl. $+ 63° 23' 55''$) was under scrutiny. It was suggested, therefore, that the star in question might be a variable one with a period of 314 years: this would very closely account for appearances in the years 0, 945, 1264, 1672, and 1887! and if it were really the star of Bethlehem, it would be naturally seen about Christmas-time. Nothing is more curious than to watch how a piece of scientific knowledge has thus settled down to form a nucleus for a haze of sensational nonsense.

But it is not impossible that, after all, we are really again in presence of the star of Bethlehem; for if we read the account in St. Matthew, and assume that some celestial body is really alluded to, and not a miraculous appearance similar to those recorded by St. Luke (chapter ii. 8-15), then it would seem that Venus, as she has been seen lately—that is, at her maximum brightness—will do as well as any other, and there is no necessity to assume either a "new star," or a comet, as giving rise to the phenomena recorded.

We give that part of the narrative which chiefly concerns us, and it is necessary to bear in mind that Bethlehem lies nearly due south of Jerusalem, and is about five miles distant.

". . . There came wise men *from the east* to Jerusalem, saying, . . . we have seen his star *in the east*. . . . When they had heard the king, they departed [to Bethlehem]; and, lo, the star, which they saw [had seen] in the east, went before them, till it came and stood over where the young child was. When they saw the star, they rejoiced."

The fact that the star was stated to be seen "in the East" would imply that it was not seen anywhere else. This is best explained by supposing a *morning* observation of a body soon rendered invisible by the light of the sun. A star seen in the East at evening would be visible all night, and could no longer be properly designated as a "star in the East." This is against the views which have been held and supported by Kepler, to the effect that a conjunction of superior planets was in question; and indeed they have already been demolished by Prof. Pritchard.

If we assume that the star was Venus at maximum brightness seen in the East in the morning, and that it rose, say, two hours before the sun, it would be about south at 10 a.m. It would seem not improbable that the journey to Bethlehem should be made before noon. The gathering of the priests and scribes would probably last till sundown, and it would be natural that the journey should be undertaken next morning. Journeys in the East are not generally now, and were probably not then, undertaken in the evening. The latter part of the extract indicates that the "wise men" did not see the star till they got to Bethlehem, and that the statement that "the star went before them" is rather an attempted explanation of its change of place than a reference to any actual observation.

The simple facts, then, seem to be that the "wise men"—no wiser, it would appear, than the average Englishman of the present day, in astronomical matters—being struck by the exceeding brilliancy of Venus, which they did not recognize, felt sufficient interest in it, or, more probably, were so soundly frightened at it, that they went to the nearest important town, Jerusalem, to find out something about it. It has been assumed that the Magi came from a *great* distance, but there is nothing to justify this, apparently; and if we go beyond the record at all we may as well accept them at once as Melchior, Balthazar, and Jasper, the kings respectively of Nubia, Chaldea, and Tarshish, whose bones are supposed to be at Cologne, though their connection with the Biblical narrative is not clear, as it

is not on record where these personages joined company before they set out *westwards* for Jerusalem.

As comets long afterwards were supposed to presage disaster, so the star may have been regarded as an indication of the approaching death of King Herod. This would start the question as to his successor, whom the "wise men" would desire to stand well with, or to "worship." With what happened at Jerusalem we have nothing to do. On approaching Bethlehem about noon, they again recognized the star over the town, as Venus would be at that time, on the supposition that the "star in the East" which they had first seen was really that planet.

Another point connected with this matter relates to the question of new stars. Supposing there were a new star in the east, why should the population be affrighted? The records of astronomy, as we have seen, tell of a considerable number of such stars, and during the last few years we have been favoured with our fair share of such appearances, and yet the world is none the worse for them. The view which has recently been put forward, with an amount of evidence to back it which almost puts it beyond question, is that in new stars we see only such phenomena as we must expect; we see the result of no unnatural dealings with the regulated order of the universe, but simply the collisions of swarms of meteorites, these meteorites being not only not in our own system, but lost, it may be, in the very depths of space. Why should such a thing as this affright us? It is simply what happens at a level crossing when a train runs into a cart, and it does not seem likely that such an ordinary piece of mechanism as this would be chosen as a means of frightening or ringing the death-knell of a world.

Modern science, while thus abolishing mystery from the skies, is only enhancing the majesty of all created things. The universal law and order are more clearly seen in every great advance; and yet, with a population so superstitious that the least uncomprehended thing affrights them, our statesmen are still on the side of ignorance, and hinder rather than aid the introduction of science into our schools.

THE MICROSCOPE.

The Microscope in Theory and Practice. Translated from the German of Prof. Carl Naegeli and Prof. S. Schwendener. (London: Swan Sonnenschein and Co., 1887.)

THIS book opens to English readers an entirely new page in microscopical literature. It leads the way in supplying a want which every thorough microscopist has realized for the last twenty years. In a complete form this treatise has been accessible to the German reader for at least ten years. The absence of it, or an equivalent, in the English language has been a most serious drawback to the advancement of the highest optical work in English microscopes. In optical manipulation, the English optician at his best proves not only equal to any in the world, but, in the highest class of work, has shown lately that he takes a foremost place. But with no attempt on the part of English mathematicians and microscopists to become masters and expounders of the theory of the microscope and of microscopic vision, the practical optician can make no real advance. English "stands," and those made in America on English models, are of exquisite construction, and are quite equal to our present necessities; but, for all the great advances and improvements that have been made in *English* object-glasses during the last fifteen years, we are, for all practical purposes, primarily indebted to Germany. And this is readily explained by the fact that the German specialists have made a systematic and persistent study of the theory of the microscope.

It is not forgotten that it was to the suggestion of Mr. J. W. Stephenson that we are indebted for the invaluable improvements that belong to the homogeneous system of lenses.[1] But, without doubt, it was on account of the insight which a study of the theory of microscopic vision brought with it, that Mr. Stephenson perceived at once the advantages of great numerical aperture, and the new way to obtain it. Moreover, it is certain that Prof. Abbe was approaching this very method of employing lenses, though from another point, and not in so direct a way. It would have been shortly reached by him there can be but little question; but when it was reached, what did a constant, enthusiastic, and laborious study of the theory of the microscope carry with it? A perception, that with glass of greater range of refractive and dispersive indices than any we possessed, we might not only secure great numerical apertures, but secure them devoid of all colour; that we could not only annul the primary, but also the secondary and tertiary, spectra. It need not surprise us then, that, in a country where such splendid theoretical and mathematical work had been done by experts on the principles of microscopic lenses and the laws of their construction and use, even the Government should be convinced that the time to aid the optical expert had come; that theory had demonstrated the practical possibility of a great improvement in the construction of lenses. The sum of £6000 was granted by the German Government to Abbe and his collaborateurs, and with, as we have reason to believe, an equivalent outlay on Abbe's own part, the new glass was prepared; and the new Apochromatic lenses with their systems of compensating eye-pieces devised.

It is in no spirit of boast, but rather in a spirit of humiliation and regret, that we say that we have examined many of these apochromatic objectives of all the powers made in Germany, and we have examined all the principal ones that have, since the new glass has reached London, been made there; and we are bound to say that the English work, based on the principles laid down by Abbe, is so fine as to make the regret immeasurably keener that English microscopical literature has been for all these years a blank, for practical purposes, on the theory and principles of optical construction, and on the theory of microscopical observation and interpretation. Such a paper as that of Prof. G. G. Stokes, P.R.S., on the question of a theoretical limit to the apertures of microscopic objectives (Journ. R.M.S., vol. i. p. 139) from its very loneliness only gives emphasis and point to our contention. Those who have any doubt of the full force of what we are here contending for, have only to compare a dry $\frac{1}{8}$-inch objective, say of twenty-five years ago, made

[1] "On a Large-angled Immersion Objective, without Adjustment Collar with some Observations on Numerical Aperture," by J. W. Stephenson F.R.A.S. (Journ. Roy. Micros. Soc. vol. i. p. 51).

by the best makers in London, with a well-chosen water-immersion of ten years ago; and both these with a recent homogeneous glass of the same power with a numerical aperture of 1·5. Or still better, a dry $\frac{1}{50}$-inch objective, of the same date and the same makers, of numerical aperture 0·98, with a water-immersion lens of the same power of say ten years ago, having an aperture of 1·04, and a recent homogeneous $\frac{1}{50}$-inch, with a numerical aperture of 1·38. Still more strikingly, let the same observations be made with a dry $\frac{1}{12}$-inch objective of twenty years ago, with a numerical aperture of 0·99, and a homogeneous lens of the same power, with numerical aperture 1·5; and, finally, both these with an apochromatic objective of the same power by the same London makers and an aperture of 1·40. We venture to say, to histologist, bacteriologist, diatomist, and all other serious workers with the microscope, that there can be no proper comparison of the results; or, rather, the comparison is odious indeed for the oldest, and even the elder, lenses.

But, as we have stated, it is to Germany we are indebted for the *knowledge* out of which, alone, these improvements could have arisen. In spite of the length and abundance of English treatises on the microscope, it has never been part of the scope of the respective authors to do other than make the scantiest reference to the principles of the microscope; and nothing is found that will elucidate the theory of the construction of objectives, and eye-pieces, and the possible and real relations of each to the other. There is nothing to be found indeed in our language, except in the invaluable translations published in the successive Journals of the Royal Microscopical Society, which discusses the phenomena of diffraction, of polarization, of the principles of the true interpretation of microscopical images, and the theory of work with the microscope. English workers with high powers have discovered painfully where their lenses during many years were at fault; they could show our opticians *what* they wanted; but it has been only as the result of the laborious mastery of the theory of lens-construction by German investigators, with Abbe at their head, that the English worker has been able to get his wants, in object-glasses and eye-pieces, supplied.

But like all advances in insight and analytical power, these very improvements, so welcome and so helpful to searchers in many important branches of science, only open up the horizon of the unknown more fully; and the very knowledge we get, through the inestimable improvements, only reveals new difficulties; and again creates optical wants. It is, then, with pleasure indeed that we hail this excellent translation of Naegeli's work on the theory and practice of the microscope The book has long been announced, and many have looked, year after year, eagerly for its coming. But a series of untoward circumstances have combined to make the delay inevitable. The translation was begun some ten years since by Mr. Frank Crisp, the Secretary of the Royal Microscopical Society, purely in the interests of microscopy in England. He wished to fill the blank in the microscopical literature of the country, which had, in fact, become almost a dishonour to us. This book of Naegeli and Schwendener is a thorough treatise on the theory of the microscope, giving a detailed theoretical exposition of the construction of objectives, eye-pieces, &c., with analytical determination of the path of the rays in refracting systems; discussing exhaustively chromatic and spherical aberration; the influence of the cover-glass; the flatness of the field of view; the centering of systems of lenses; the importance of aperture, with a discussion of the diffractional action of the aperture of the lenses; and the question of illumination.

With equal care and thoroughness there is a discussion of the testing of the microscope, in all its branches, which cannot but make the student conversant with every essential point in the construction of the instrument; and an absolutely invaluable monograph on the theory of microscopic observation, which no one attempting to publish results of any importance dare leave unread or even unstudied. The phenomena of polarization receive equal care in treatment and must prove of the utmost value.

To put such a book within the reach of English readers, Mr. Crisp rightly felt, would be to give the needed stimulus to English microscopical observation: it would put them on the same horizon with German specialists. But the first impediment to its appearing in print was, that Mr. Crisp was compelled, by the weight of other claims upon his time, to relinquish the task of preparing the translation for the press when only eighty pages were in type; and a large lapse of time ensued before the labour was at length resumed by Mr. John Mayall, Jun., one of the editors of the Journal of the Royal Microscopical Society. But, beyond this, when Mr. Mayall had done his work and the printing of the work was complete, a fire destroyed the premises of the printer and all but a small portion of the type was wholly lost. The present issue is therefore an entire reprint.

There is but one point that we can see in the book, as it now stands, that need call for the slightest reflection: it is that the authors adopt, and discuss at considerable length, a method of testing the resolving power of objectives which has had—in another connection—the honour of a mathematical refutation by the highest living authority on microscopical optics, Prof. E. Abbe, of Jena. This method consists of viewing, with the objective to be tested, what were assumed to be "miniatured images" of a network of wire gauze produced by minute globules of oil and other matters, which images were supposed to be reduced to the "limit of discrimination" by simply distancing the wire gauze from the oil globule. Prof. Abbe's demonstration (*vide* Journ. Royal Micros. Soc. 1882, pp. 693-96) of the fallacy of this method proves that the combination of a microscope with a minute oil globule, or its equivalent, for viewing a distant object—whether wire gauze, or a so-called "double star" arrangement as advocated by Dr. Royston Piggott—serves no purpose whatever in determining the limit of the resolving power of the objective; but merely produces a very low-power telescope; the power of which may easily be so low, indeed, that the eye fails to differentiate, or even to perceive, the image!

The adoption of this fallacious mode of reasoning, however, amounts only to a blemish in an otherwise most excellent work; and with the publication and accessibility of Abbe's correction can do but little harm.

It would have given a still higher value to the book if the chapters devoted to an exposition of Prof. Abbe's

views on the formation of images in the microscope had received the advantage of his personal and later revision; but it is none the less due to the authors to acknowledge the credit that is justly theirs, for the very early recognition of the value of his investigations; and for the earnest manner in which they endeavoured to embody those investigations in a popular text-book at a date (1877) when hardly more than the barest outlines of the subject had been published by Prof. Abbe himself.

We note that the authors give the preference to daylight over lamp-light, believing that it exerts less strain upon the eye. We suspect that the majority of English observers, especially at continuous work, and with high powers, will be inclined to reverse this judgment. Extremely white and intense light can be obtained from good modern lamps, and, unlike daylight, it is unvarying, devoid of caprice, and easy of manipulation. But this is a matter, perhaps, in some sense subjective, and not of vital moment.

The world of science generally and of microscopical science in particular, is deeply indebted to Mr. Crisp for initiating this translation, which, we have taken pains to find, is most carefully done; and to Mr. Mayall for his part of the laborious undertaking. We can only hope, in the interests of English and American science, that it will find a large circle of careful readers on both sides of the Atlantic; and we warmly concur in the hope expressed in the preface, "that the volume may be supplemented before long by an English version of the further researches in microscopical optics by Prof. Abbe, of Jena, which have extended so much our knowledge of the matters dealt with in Naegeli and Schwendener's work."

W. H. DALLINGER.

THE CRUISE OF THE "DIJUMPHNA."

The Cruise of the "Dijumphna." With Reports of the Zoological and Botanical Results of the Voyage. By R. Bergh, J. Deichmann Brandt, J. Collin, H. Hansen, T. Holm, C. Jensen, G. Levinsen, C. Lütken, L. K. Rosenvinge, M. Traustedt, and N. Wille. (Copenhagen, 1887.)

THE Danish Arctic Expedition of 1882-83 owes its initiative to its able commander, Lieut. Hovgaard, of the Danish Navy. This enterprising officer, whose practical experience of Arctic navigation gave great weight to his opinions on the subject, had early in 1882 published a pamphlet, entitled "Suggestions for a Danish Polar Expedition," in which he advocated his own theories regarding the distribution of land and water in the Arctic regions, and the feasibility of finding some hitherto untried route for circumpolar exploration.

In response to his appeal for means to test the accuracy of his opinions, a private individual, Herr Gamél, of Copenhagen, placed at his disposal a screw-steamer, since known as the *Dijumphna*, whose equipment for Polar explorations and scientific observations was supplemented at the expense of the Danish Ministry of Marine.

Thus well prepared, the Expedition left the Copenhagen Roads, July 18, 1882, but unfortunately the *Dijumphna* early encountered ice, which was found to be so dense south of Cape Tschernui Noss that it was only after a delay of more than four weeks off the south-west coasts of Nova Zembla, that an entrance could be made into the Sea of Kara, where, in accordance with Hovgaard's anticipations, the water was clear. The hopes of success to which this fact gave rise proved, however, delusive, for the ice began to re-form so rapidly that, within a few days of their passage into the Kara Sea, it had become apparent that the *Dijumphna* was fast bound for the coming winter; and it was only after nearly a twelvemonth's detention that the ice began to loosen, when the westerly trend of the drifts carried the ship, in the August of 1883, back towards the entrance of the Sea of Kara. With a broken screw and failing supplies, there was no alternative but to renounce all hope of advancing further east, and, accordingly, by help of sails the *Dijumphna* began its homeward voyage, which was so retarded by ice-drifts and storms that the harbour of Copenhagen was not reached till December 3, 1883.

In the course of the winter the sun remained below the horizon from November 20 to January 22, the temperature at the latter date falling as low as $-47^{\circ}\cdot 9$ C.; while there was constant danger of being crushed in the ice, or carried with moving drifts on the shore. Yet, notwithstanding these drawbacks, the trawl and dredge were diligently used at 190 different stations, ten of which were in the Jugor Schar and in Olenje Sound, off the south-west coast of Nova Zembla. Most of the deep-sea soundings were carried on in the Sea of Kara, between 69° 42′ N. lat., 64° 45′ E. long., and 71° 46′ N. lat., 65° 14′ E. long., within which limits the ship was moved forward and backward by the ice-drifts. This ground proved specially rich, and Herr Holm, the efficient naturalist of the Expedition, was able to bring home an exceptionally large number of well-preserved botanical and animal collections, which now form a valuable addition to the contents of the Danish National Museum, to which they have been generously ceded by Herr Gamél, the owner of the *Dijumphna*.

Herr Holm's report of the flora of Nova Zembla, which he examined at twelve distinct localities during the *Dijumphna's* long detention off the coast, confirms the statement of Von Baer as to the abundance of vegetation on the tundras, but he differs from him in regard to the mode in which plants found their way into these high latitudes. According to Von Baer, to whose report of his scientific mission, undertaken for the Russian Government in 1837, we are indebted for our first acquaintance with the Nova Zembla flora, its plants have all been stranded from neighbouring shores through the agency of drifting ice. Herr Holm, on the other hand, believes that a few forms may be survivals from pre-glacial periods, but that the presence of the majority is due partly to the agency of birds, of which large numbers, more especially Tringa and other waders, frequent the shores, and partly to the winds, and to ice-drifts. Insects are too rare to affect the question of plant-propagation, and his observations—that most plants on the tundras have the corolla directed upwards, while pendent or drooping forms are very rare, and that the majority are scentless, and of one uniform colour—appear to favour these views; although it is possible that the existing flora may also to some extent be due to self-fertilization.

The general appearance of the tundras is that of a slightly irregular plain, the irregularities being due to the tuft-like character of the patches of vegetation, which are separated by pools and streams of melting ice, from which innumerable mosses emerge. When closely examined, these tufts are found to consist of plants dwarfed out of all resemblance to their more southern congeners; thus, *Salix polaris* never rises more than 2 inches in height, although the number of its annual layers of growth—consisting only of five to six cells—may indicate an age of thirty years. Considered generally, the Nova Zemblan flora consists of twenty-eight families of Dicotyledons, four Monocotyledons, and four Cryptogams. Among the Phanerogamæ the most largely represented are the Gramineæ, of which thirty-one species have been distinguished. Curiously enough, it is found that contrary to their habits in more southern regions the Dicotyledons flower earlier than Monocotyledons, which contribute the larger proportion of the flora of the tundras, both as regards species and individuals. The number of new phanerogamic forms derived from the *Dijumphna* Expedition scarcely exceeds a dozen, and of these the most interesting are *Salix arctica*, *Glyceria tenella*, *Potentilla emarginata*, and three species of Carex, viz. *C. incurva*, *lagopina*, and *hyperborea*. As many as eight species of Saxifraga were met with, while Phaca is the only representative of Papilionaceous plants.

Special interest attaches to the collection of mosses brought home by Herr Holm, and examined by Herr C. Jensen, whose report shows that among the entire sixty-four species, of which fifty-one belonged to the tundras and the cliffs of Nova Zembla, three were genuine Arctic forms, viz. *Voitia hyperborea*, *Bryum obtusifolium*, and *Amblystegium brevifolium*. In Wulfberg's report of the mosses collected in the Norwegian Expedition of 1872, which is the only other notice of the Arctic Cryptogams, only twenty-four are noted, so that we owe our acquaintance with forty species to the industry of the *Dijumphna's* collectors. Herr Holm was equally fortunate in finding hitherto unrecorded fresh-water Algæ in South-West Nova Zembla; but in regard to the marine Algæ he has little to record that had not been previously made known, while he corroborates the statements of earlier explorers as to the luxuriant profusion of gigantic Laminariæ, which fringe the coasts at a depth of from 1 to 5 fathoms, where he obtained fronds of *Alaria esculenta* more than 15 feet long.

In passing to the consideration of the zoological results of the *Dijumphna* Expedition, we must admit that excepting in regard to the Invertebrata, for whose capture no better hunting-grounds than such Laminarian forests can be wished for, the results are negative rather than positive. Of the higher marine Vertebrates only *Phoca fœtida* and *Odobœnus rosmarus* were seen. A few foxes were noted, and a young she-bear was shot, which was the only specimen of big game attainable. Fishes, mostly belonging to Icelus, Lycodes, and Liparis, were taken so sparsely in from 49 to 106 fathoms that only twenty-eight out of the entire 190 trawls yielded a single specimen. In regard to the Invertebrates the yields were, however, enormous, showing an astonishing abundance of animal life in the Arctic waters. Thus, one haul brought up 928 specimens of *Glyptonotus entomon*, 300 of *G. Sabini*, besides enormous numbers of Alcyonidæ, Sponges, Actinias, and other Polyp forms. Nor was this an exceptional case. In the Sea of Kara the Echinodermata ranked first as to individual numbers, but Crustaceæ as to species, eighty-two of the latter having been determined, of which ten belonged to the family of the Pycnogonidæ. Among Crustaceans generally, seventeen new species have been established by Herr Hansen, whose report supplies much interesting and novel information in regard to the structure of the foot-jaws of the Isopoda, of which he proposes to treat more in detail in a special monograph on the buccal organs and antennæ of the most important Crustacean types.

Gastropods and Annelids were of rare occurrence, and only one genus of Cephalopods, Rossia, was observed. The Simple Ascidians, which have been carefully studied and reported on by Dr. Traustedt, have relatively speaking yielded many novel results, while five of the eight species collected are new, of which the most interesting are *Phallusia dijumphniana* and *P. glacialis*.

The volume in which the various reports on the *Dijumphna* collections are contained is well got up, like other works of a similar character that have been brought out under the joint co-operation of the authorities of the National Museum of Denmark, and of the Carlsberg Institute. The latter of these bodies has liberally advanced the funds necessary for meeting the expenses of publication, in anticipation of the grant of 10,000 kroner to be voted for the purpose in the next year's Parliamentary Budget.

The work has been carefully edited by Herr Lütken, who contributes the monograph on the fishes, and to him foreign readers are indebted for a French *résumé* of the report on the vegetation of Nova Zembla, and for a general summary of the fauna of the Sea of Kara in the same tongue. Besides his very complete botanical reports, Herr Holm contributes a short prefatory account of the cruise, which, if it unfortunately failed in adding to our geographical knowledge of the Arctic regions, has at any rate supplied naturalists with much valuable material towards a closer acquaintance with the conditions and forms of vegetable and animal life in those high latitudes.

EXERCISES IN QUANTITATIVE CHEMICAL ANALYSIS.

Exercises in Quantitative Chemical Analysis; and a Short Treatise on Gas Analysis. W. Dittmar, LL.D. (Glasgow: William Hodge and Co., 1887.)

IT has probably been the case with all books on practical chemistry, and especially quantitative analysis, that in the first instance a rough plan or outline of the work was used by the teacher in his laboratory, there to undergo a process of extension and development. In some cases this development has gone on until we have such classical compilations of tried analytical processes as Fresenius's quantitative or Crookes's special methods. This seems to be a natural plan. Try your plan on your own students, and, if there a success, publish for the possible benefit of a wider circle. There is only this difficulty,

that, outside certain fundamental operations and stages in teaching, teachers and schools differ considerably in detail, and it is precisely on this detail, or order of importance in some cases, of work that a teacher prides himself —or thinks he has the right plan—as being able to turn out the most satisfactory students or to save their time.

The author of this book in his preface tells us that a preliminary edition was issued a little more than a year ago for his own students, and that the work had been even before then in use as a typographed book for some time. He likewise makes some remarks about the drilling of students in the beginning of their quantitative exercises with which we fully agree. Our experience is that a student requires standing over during the first four or five quantitative exercises. If the author's production shortens that ever so little, it will be a service to teacher and student alike. As to the interpolation of a preparation, the importance of this has scarcely been recognized by teachers. There is no doubt that a judicious selection of preparations, the end product of which is to be analyzed, is one of the best methods of preparing young students for practical analytical work.

After the exercises in weighing and measuring and determination of specific gravities of solutions, the book proceeds to a series of exercises in analytical methods. In these methods lies at once the strength and weakness of the book. We have a considerable number of methods for the analysis of things—salts, &c.—of technical importance, the performance of which would leave a student in a strong position as regards practical knowledge; but it is very questionable indeed if the average student could work through the majority of these, in the absence of the instructor, from what is given in the shape of directions. The exercises under separation are very well selected. They include a number of ores and alloys, silicates, &c. In the process of separation of lead and antimony by chlorine (p. 137) the author might have improved on the use of manganese by using permanganate, the evolution of chlorine is more regular.

Then follows combustion analysis for C, H, and N, and gas analysis. The latter forms the largest and best section of the book. It is mostly taken from, and is after the style of, Bunsen's gasometry. Other methods or modifications are also discussed as far as is requisite in a book of this nature. We have, finally, a number of "promiscuous exercises" in applied analysis: sea-water —mostly after the author's report on the composition of ocean water—milk, butter, and other substances.

On the whole, the book is a careful compilation and arrangement of work for students, bearing unmistakable evidence of the author by the references to his work and methods. We take leave to object to "Knallgas" as not being very generally understood by English students. It is not much shorter than electrolytic gas, and although the employment of it is explained it serves no very useful end. But this and one or two other details are not great objections, and do not detract from the utility of the book, which attempts perhaps too much, but may be fairly commended to those students of chemistry intending to become analysts, especially of technical products.

W. R. H.

THE STUDY OF LOGIC.

A Short Introduction to the Study of Logic. By Laurence Johnstone. (London: Longmans, Green, and Co., 1887.)

THERE is naturally some interest attaching to a book on logic which bears the *imprimatur* of Cardinal Manning, and of which a responsible member of the Society of Jesus can say *nihil obstat.* The Jesuits have long been famous teachers, and it is possible that those who find elementary logic an unsatisfactory teaching-subject may glean some useful hints from this little volume.

From a point of view outside the Roman Church, the perennial difficulty in the study of logic consists in the fact that no firm line can be drawn between the most elementary logical doctrines and the highest possible flights of philosophical reflection. As logic is taught by and for free-thinkers, both student and teacher are in a constant state of climbing ladders only to kick them down. At all stages a higher and a lower logic are at variance, or rather the higher logic consists in nothing else than a criticism of the lower. Distinctions that have been our mainstay become mere obstacles: our later views are mostly not additions to the earlier ones, but subversions of them. Hence there is little beyond the bare history of the subject, and a few of the less important technicalities, that can be taught with any authority.

In Mr. Johnstone's book we find throughout a wholly different attitude taken. With quiet simplicity, questions over which modern philosophy has spent much heat and labour are boldly prevented from arising. Thus a student may read, on page 10, under the heading "Action of the Intellect," that "the mind is a *tabula rasa* before it receives any impressions from without. It receives impressions, or the matter for ideas, through the senses, upon which the impression is made. By means of the 'sensus intimus' man becomes conscious of these impressions, of which the imagination then forms a picture, or phantasm." And then "from the picture on the imagination the intellect draws that element which is akin to itself, that is the immaterial incorporeal element, throws it into its mould—so to say—and the result is the 'species intelligibilis,' formed in the intellect itself, and representative of the exterior thing." What could be more final and satisfactory? It is not everyone who is free to make so short a piece of work of one of the largest of all philosophical questions. And so the student gets something that he can definitely carry away, and produce on paper when required.

Another noticeable feature is the revival, throughout the work, of many distinctions which have dropped out of sight in our modern text-books, or are at most referred to vaguely there with a passing smile at the "fruitless subtlety of the schoolmen." These can plainly be made to serve two purposes,—they provide abundance of material for the student to exercise his memory upon, and their effect as a whole must be to keep as separate as possible the process of using the machinery of logic, and that of seriously criticising our own beliefs. It is only from the free-thinker's point of view that any real desire can be felt to make logical criticism practically effective to the utmost. If we are anxious above all to

guard some piece of faith as such, then the more wordy our logic the better. And the delight in "naming our tools" may be carried to any length without fear of unpleasantness. It need commit us to no more than did Mr. Micawber's plan of docketing his unpaid bills. Here, however, it must be left an open question whether the modern practice of ignoring so many carefully-made divisions is an improvement or the reverse. Both views are at least respectable. In any case the elaborate details of the machinery by which our religious creeds are to be kept sacred contain much that ought to be of interest to all. What with *criteria per quod* and *secundum quod* (pp. 168, 191), with different "spheres" of truth (pp. 175, 202, 203), and different kinds of certainty (pp. 161-68), with truths which are "not intrinsically evident, but nevertheless extrinsically evident, or, rather, evidently credible" (p. 200), one may learn to admire heartily the care and cleverness employed so freely in mediæval times by those who felt the need of warding off awkward questions. It is certainly no light problem, how logic may be taught without encouraging the dangerous practice of doubting what we are told.

There are other signs of hard work in this book, besides the patience with which the author has studied the scholastic doctrines. For teaching purposes there is nothing so useful as examples, and here the examples given are numerous, mostly new, and sure to be helpful to the learner. Only those who have tried know the real difficulty of clearly illustrating statements so general as those of logic without some appearance of triviality. In this respect also Mr. Johnstone has succeeded unusually well.

ALFRED SIDGWICK.

OUR BOOK SHELF.

Light and Heat. By the Rev. F. W. Aveling, M.A., B.Sc. (London: Relfe Bros., 1887.)

THIS is an elementary text-book intended to cover the syllabus of Light and Heat for the London Matriculation Examination. Being written more in the form of notes than as an ordinary book, it will be of considerable service for examination-purposes. Many of the definitions, however, are far from concise, and many phenomena which admit of easy explanation are left unexplained. On p. 98 we are told that the specific heats of gases are inversely proportional to the square roots of their densities, whereas they are in inverse proportion to their densities; had a simple explanation of this relation been given, the mistake would not have occurred. The important subject of thermo-dynamics is disposed of in four pages at the end of the book: this is not as it ought to be, seeing that the relation between heat and work often enters into previous discussions, and is, moreover, the basis of the modern theory of heat.

The sketches are of a rough-and-ready kind, such as a student would be expected to make in an examination, and, as such, give many useful hints. The coloured plate of spectra, however, is as useless as the majority of similar ones, as practically no explanation of the meaning of a spectrum is given; dark lines are shown in the spectrum of potassium, but these are no doubt due to a mistake of the lithographer. Such exhibitions as these, which are far too common, show a want of respect for the labours of those who have done so much to further our knowledge of spectrum analysis.

A large number of good numerical problems, with answers, are distributed throughout the text, and several typical ones are fully worked out.

A. F.

Animals from the Life. By H. Leutemann. Edited by Arabella B. Buckley. (London: Stanford, 1887.)

THIS work, which forms a charming introduction to the study of zoology, is just the thing for young children who have a turn for the subject, and at the present time, since presents are being made on all sides, would make a very useful and enjoyable gift. From it they will be able to become acquainted with the various forms of living creatures without having to make a laborious study of natural history, which few care to do. A great amount of knowledge can be gained by merely looking at the illustrations, which are got up in a very intelligent and accurate style; they are 255 in number, and well coloured, and represent animals, including birds, insects, fish, &c., as they are found in their natural state.

The accounts of the various forms and habits of the different animals (each plate having about a page and a half of letterpress with it), are written so very clearly and in such a natural way that anyone who peruses this book will find plenty that will be extremely interesting.

In adapting the original text to the wants of English children, Miss Buckley has had to alter it in many places, English examples and references being substituted for German ones.

The Vegetable Lamb of Tartary. By Henry Lee. (London: Sampson Low, 1887.)

IN former times it was generally believed that there existed in the East a mysterious "plant-animal," variously called "the vegetable lamb of Tartary," "the Scythian lamb," and "the Barometz," or "Borametz." The usual explanation of this notion is that it originated from certain little lamb-like toy figures constructed by the Chinese from the rhizome and frond-stems of a tree-fern. Mr. Lee, however, holds that the idea came into Europe from Western Asia, and that it referred in the first instance to the cotton-pod. This theory he works out thoroughly in the present little work, and in the course of his argument he has brought together many curious and interesting facts, the significance of which is made more plain by a number of good illustrations. In a separate chapter Mr. Lee treats of the history of cotton, its uses by ancient races in Asia, Africa, and America, and its gradual introduction among the nations of Europe.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*

The Royal Horticultural Society.

THE affairs of the Royal Horticultural Society alluded to in the last issue of NATURE (p. 145) have lately obtruded themselves upon public attention, but it is probable that some readers of NATURE may consider that they have little concern with such a body. They may look on horticulture in the light of a pleasant pastime, or of a more or less profitable commercial enterprise, they may regard flower-shows as a means for the display of fashionably-dressed ladies, or they may look on the Royal Horticultural Society as an association for the production and distribution of medals and certificates of more commercial than scientific importance. But there are other considerations beyond these, and whilst naturalists may be indifferent to much of the past history and much of the present work of the Society, to the internal dissensions and to the action of the landlord Commissioners towards their unfortunate tenants, the scientific work of the

Society may well excite their sympathy. A moment's consideration will show that the progress of horticulture is largely based on the correct application of scientific principles. What is not so familar to most people is the extent of the obligation under which science generally lies to horticulture. Should any reader require an illustration of this, let him turn to the "Origin of Species," and specially to the "Variation of Animals and Plants under Domestication." There is scarcely a page in the chapters of those volumes relating to plants that does not abound in references to the practices and the discoveries of horticulturists. Fertilization, cross-breeding, hybridization, selection, grafting, the limits and nature of variation, are only a few of the subjects on which horticulture furnishes the largest and in many respects the most trustworthy body of evidence yet available. That these subjects are studied, and that the experiments are made, not so much from a scientific as from a utilitarian point of view, is surely no matter of reproach. On the contrary, it is the business of horticulturists to act as they do, but without the aid of a Society much of the experience gained would be lost to science. All this might be admitted as a general principle, but yet its concrete application to the Royal Horticultural Society might be from various causes inappropriate. The Society in question has, however, distinct and undoubted claims to recognition for the good work it has done in science for a long period of years. The services it has rendered to science by its collectors, and the still greater value of its work in all departments of practical horticulture, should have secured for it more sympathetic and respectful treatment from its landlords. Among Societies deserving of national support and encouragement on the ground of public utility, there are few, indeed, that have greater claims than this. For years it has unfortunately been hampered by the necessity of providing amusement for a body of Fellows and visitors who cared nothing whatever for horticulture in its higher aims. Now there is a chance of the Society bursting its bonds and confining itself to its proper work —the promotion of scientific and practical horticulture. The plan of catering for fashionable idlers has proved disastrous. While horticulture proper was starved, and thousands upon thousands of pounds were utterly wasted, the landlords retain the whole of the property on which their tenants expended so much, and the Society has to seek a new home. In spite of all this, however, a valiant attempt has been made throughout long years of depression to maintain the scientific traditions of the Society. There has always been a small body of Fellows who have been mindful of the obligation which Thomas Andrew Knight, so long the President of the Society, imposed upon his successors. Lindley for forty years maintained the scientific interests of horticulture in the Society, and he was assisted by Royle, by Bentham, and many others. Twenty years ago, or more, a Scientific Committee was appointed, and this body, recruited by new accessions each year, still continues its labours. Under its guidance experiments have been performed in the Society's Experimental Garden at Chiswick; under its sanction have been published numerous Reports of very great scientific interest and importance; and much more might and could have been done but for the lack of means, or rather their diversion for more questionable purposes. The Committee in question consists of some twenty or thirty naturalists of all denominations—botanists, chemists, geologists, entomologists—associated with amateur and professional gardeners interested in science. To this body are referred for discussion and investigation the most varied objects of natural history and vegetable pathology; before this body and its sister committees are brought all new introductions, whether of natural origin, or produced by the skill of the gardener, and which have any scientific interest. Sir Joseph Hooker is the Chairman of this Committee, the Rev. M. J. Berkeley was for many years its Secretary, and a large number of the most eminent biologists, chemists, and geologists have been or still are among its members, giving their services without fee or reward, simply in the interests of scientific horticulture. On these grounds, therefore, the sympathy and co-operation of those interested in science may be claimed on behalf of the Royal Horticultural Society. A new programme has been decided on in principle, a new home must be provided at once, for the purpose of the Society's meetings and for housing the Lindley Library. This library, it may be added, is held in trust for the benefit of the Society, and is from time to time enriched by donations and by purchase, so far as the very meagre income of the Trustees permits. The donations would be much more numerous were it generally known that the library, though primarily intended for the Fellows, yet is under certain restrictions available to outsiders, so that, though housed in the Society's rooms, it cannot be sold or made away with in any financial catastrophe which might overtake the Society. Such a fate, however, seems to be averted at present; the Society's debt is not large, and some members of the Council, or other friends, have made a good beginning by inaugurating a fund, to be used for the housing of the Society, so that ere long we may hope to see the old Society established on a more secure basis, and more potent than ever to advance those interests of science committed to its special keeping.

MAXWELL T. MASTERS.

Classification of Clouds.

As one who has been engaged for nearly forty years in working up the materials for a monograph on clouds, I suppose I deserve the name of a "specialist in clouds" as much as any one. Yet I decline, for reasons which I will hereafter state in an appendix to my volume, to be altogether bound by the outlines of classification which my friends Prof. Hildebrandsson and the Hon. Ralph Abercromby appear to lay down (NATURE, December 8, p. 129 *et seq.*), although they adopt several of the names which come from my mint. I fully adopt the opinion implicitly held by Mr. Abercromby, and stated by my friend Captain Barker (*ibid.*)—from whose classification, however, I differ in one important point—that all ordinarily careful observers will readily comprehend the broad and simple distinctions expressed in any fairly good classification. Nevertheless, I believe that the apparently slow progress of this branch of research, and the tediousness of the work thrown upon the classifier, are matters on which we should congratulate ourselves, since every year adds something to our knowledge of those physical and structural processes which form the basis of all true classification; and I trust that some years may pass before an International Congress may attempt finally to set its seal upon any nomenclature or classification of clouds.

W. CLEMENT LEY.

Effect of Snow on the Polarization of the Sky.

THE polarization of the sky has been shown experimentally by Tyndall and theoretically by Lord Rayleigh to be due to fine particles suspended in the atmosphere. According to both, the sunlight scattered at right angles to its original direction by very small particles is completely polarized in a plane through the sun. In observation, however, we find the light from a region of the sky distant 90° from the sun is only partially polarized. This is due to that portion of the atmosphere being illuminated not merely by the sun, but also by the rest of the sky and the surface of the earth, and partly also no doubt to some of the particles not being sufficiently small compared with a wave-length. From these considerations we may expect that a fall of snow would cause a considerable diminution of the polarization. This expectation has been fulfilled in some recent observations of mine here at 6000 feet above sea-level. My polarimeter consists essentially of two piles of glass plates to depolarize the sky light; and a crystal and Nicol prism to test the depolarization. Owing to the strength of the polarization at this altitude, I find it necessary to use two piles of glass plates separated by two or three inches. This arrangement diminishes the number of double internal reflections, and so is a much more powerful polarizer or depolarizer than the same number of plates combined into one pile. As I have not seen this important practical consideration noticed before, I may point out that, in addition to the light refracted directly through the pile, there are a number of portions twice reflected. One of these for instance is reflected first at the second surface of the last plate, and secondly at the first surface of the last plate. The number of such twice-reflected portions for n plates is $n(2n-1)$. When, as in my instrument, the fixed pile is much inclined, no light can reach the edge after being reflected first by one pile and then by the other. If the two piles were combined into one, I should have 120 portions twice reflected; as it is, I have only 60. This increases the polarizing power of the instrument by at least one-third.

The crystal is a thick plate of Iceland spar cut so that the light passes along the optic axis. The fixed pile of three plates has its normal inclined at 47° to the axis of the crystal. The movable pile of five plates has an index attached, which gives the inclination of its normal to the axis of the crystal. This inclination is the reading of the polarimeter.

St. Moritz lies on the northern slope of a valley running from south-west to north-east. At the beginning of the observations the opposite slope was buried in snow, but the northern slope both above and below the point of observation was almost free from snow. Thus the most brightly illuminated part of the ground surface was of a dull brown or gray colour. Under these circumstances, the reading was about 50° in the middle of the day, being a little higher earlier and later, viz. about 52° at 10 a.m. (date October 21 and 22). These readings, as well as those mentioned below, refer to the highest point of the sky, which is distant 90° from the sun, and were taken when the whole sky was free from cloud. On October 26, after a five inch fall of snow, the reading was 41° at 10.15 a.m.

By October 29 most of the fresh snow had gone, and I found at 11.40 a.m. the reading as high as 48°. After this we had several feet of snow, and at 12.50 p.m. on November 13, the reading was again 41°. Each of these readings is the mean of four, and I find two readings of the same thing seldom differ more than 2°. Hitherto I have not been able properly to evaluate the readings of my instrument in absolute measure, though I hope to do so later. But to gain an approximate idea of their meaning, I have calculated the polarizing power of the two piles on the assumptions—first that Fresnel's laws of the reflection of polarized light are accurate, and secondly that the index of refraction of my plates is 1·52. We may consider the light from the sky as consisting of two parts completely polarized, one in the plane of the sun, and the other perpendicular thereto. The ratio of these parts is ·376 for the reading 40°, and ·271 for the reading 50°. Again we may divide the light into a part unpolarized and a part completely polarized in the plane of the sun. The ratio of these parts is ·546 for 40° and ·428 for 50°. So it seems fair to conclude that the light reflected from the fresh snow was sufficient to increase the unpolarized part of the sky light by more than a quarter. JAMES C. MCCONNEL.

St. Moritz, Switzerland, December 10.

The Ffynnon Beuno and Cae Gwyn Caves.

I WILL answer Dr. Hicks's question in as few words as possible. Nothing is to be gained by terming me a "highly prejudiced" observer, or by saying my views are of "no consequence" and "not worth anything." Your readers can form their own conclusions on these points. I am not "highly prejudiced" against, neither have I any "bias against," the existence of pre-Glacial man or of his "migrations"; on the contrary, I favour these subjects.

I *did* see the section of drift exposed at the Cae Gwyn Cave, and I can hardly describe it (from my own point of view) without giving offence. My view is this: the section showed nothing but rain-wash derived from the closely-adjoining non-Glacial drift. The section showed a re-made deposit, horizontally stratified, and with stones resting on their flat sides. No doubt there were Glacial stones in the rain-wash, derived from the ever-shifting post-Glacial marine drift close by; the latter being merely a re-laid Glacial drift. Stones with Glacial scratches may be found in the lower gravels of the Thames.

To me, the caves and their surroundings are in the highest degree suspicious, and in size insignificant, and not comparable with large and typical caves. They are small and painfully narrow tortuous passages only, on a hill-side, and *close to the surface*. The lower cave is furnished with a very large hole, opening up to the surface just above; and the upper cave had at one time a similar opening. The post-Glacial drift above is always on the move, and every shower of rain brings it down with its derived stones.

Since writing to NATURE, in November 3, I have referred to some of the papers published on these caves. I turned first to the list of mammalian remains, only however to find that the animals (like the implements) are entirely *characteristic* of the most recent post-Glacial deposits. Even near London we get in gravels of no great comparative antiquity the bones of *Elephas antiquus*, but in the caves merely *E. primigenius* is found. As regards antiquity, the animals no doubt overlap at both ends of the scale, but their meaning, as found in these caves, points in one direction only, and that is to the most recent and not to the most remote of Palæolithic times. None of the cave mammals are *characteristic* of pre-Glacial deposits.

It would seem that Dr. Hicks does not realize the nature of Dr. John Evans's criticism. La Madelaine is the newest of caves, and represents the most recent of Palæolithic times: it is a kind of connecting link between Palæolithic and Neolithic times. Therefore, if Dr. Evans's criticism is taken with mine, the two *clearly prove* that there *is* a distinct chronological value in the classification, not that there is "no chronological value" as concluded by Dr. Hicks. Dr. Hicks also appears not to realize the fact that river-drift and cave implements do not only differ in roughness and abrasion but in style. The cave men used different implements from the river-drift men, they were changing from savagery to barbarism. If Dr. Hicks produces implements made by pre-Glacial men, he must show us something obviously older than the oldest river-drift tools, not fall back upon refined tools which are, to re-quote Dr. Evans, "precisely like many from the French caves of the reindeer period, such for instance as La Madelaine." If Dr. Hicks abandons his scraper, he is still in no better position, for his finely re-trimmed knife and the implement in the British Museum are identical in age and character with it. So are the flakes: the one with long narrow facets is characteristic of the latest, not of the earliest work. So is the pointed and drilled bone. No drilled bones have been found in moderately old river-gravels, and what is more, no instrument suitable for boring a small hole through bone has ever been found in such a gravel. Drilled bones and small flint drills belong to the very latest of Palæolithic times. In the remains of my own collection of Palæolithic implements I have here over a thousand examples of the major class, and an equal number of minor forms illustrative of the development of knife and scraper forms, but they give no support whatever to Dr. Hicks's conclusions; they all, in fact, point in a diametrically different direction. I am acquainted with Prof. Prestwich's views, and I believe I was the first person to find implements in the highest terraces of the Thames Valley; but I do not see that Prof. Prestwich's conclusions have any direct bearing on the Ffynnon Beuno and Cae Gwyn caves.

I do not suppose that any opinion of mine will influence Dr. Hicks, and I have no wish to influence him or any other observer. I merely wish to put on record the fact that, after many years' experience amongst drifts, and implements, and fossil bones, my conclusions are entirely opposed to Dr. Hicks's.

Dunstable. WORTHINGTON G. SMITH.

P.S.—Since the above has been in type, I have seen the report in last week's NATURE (p. 166), but I prefer to let my letter stand just as written before the report was seen by me. Prof. Hughes has cut away the geological and palæontological supports; I shall be content to resist the idea of the pre Glacial age of these caves on purely archæological grounds.—W. G. S.

The Planet Mercury.

THE planet observed on the mornings of December 7 and 9 by your correspondent "G. F. P." (NATURE, December 15, p. 151), was probably not Mercury but Jupiter, as these bodies were near together at the time, and the latter was by far the brightest and most conspicuous. The circumstances, described by "G. F. P.," under which the object was noticed render it certain that it could not have been Mercury, for the latter was decidedly small, and might have been easily overlooked on the several mornings I saw it early in the present month. Jupiter, on the other hand, was very bright and plain, and might easily attract attention in the way stated by your correspondent. On the 9th instant the two planets were about 3° apart, Jupiter being situated to the west of Mercury.

Had "G. F. P." really observed the latter planet, he would have instantly remarked its half-moon phase in his 3¼-inch telescope, and must have mentioned Jupiter, as well as Venus, as visible at the same time.

There is no difficulty in observing Mercury with the naked eye if the planet is carefully looked for in the proper spot, at the times of his eastern elongations in the first half of the year and at the western elongations in the last half. I have seen the planet on certainly more than fifty occasions. In May 1876 I noticed Mercury on thirteen different evenings. Sometimes the planet is quite conspicuous in the twilight as a naked-eye object. W. F. DENNING.

Bristol, December 16.

Meteor of November 15.

IN NATURE of December 1 (p. 105) Mr. B. Truscott writes of a wonderfully fine meteor seen at Falmouth on the night of Tuesday, the 15th ult., and asks in effect if it was seen by other

eyes than his: so perhaps it may be permitted to be said that it was seen in the parish of Llanefydd, Denbighshire, by a correspondent of mine, who writes:—"On Tuesday night, November 15, while returning homewards on foot, happening to look eastwards I saw a long train of brilliant light suddenly flash out of the sky. At first I thought it was lightning. But instead of vanishing it descended with great rapidity, the light increasing in brilliancy as it neared the earth. The night was rather dark, although the sky was thickly studded with stars, but in a few seconds so intensely brilliant had the light become that a pin might have been picked up from the road with the greatest ease. While I was looking, the object that accompanied the flash burst, and displayed a magnificent mauve and red fringe of light. I say fringe, as it would be impossible for me to describe otherwise the shape, for it appeared to me to project shafts of light, some long and some short, like what would be the rays of a great star. There was in the direction in which I was looking a thick wood, and the effect on the trees of the silvery light I first noticed was richly beautiful. But the effect of the mauve and red light was magnificently grand, and to me in no little degree awful. The whole wood was enveloped in a red lurid glare, which lasted as near as I can calculate some six or eight seconds. The effect altogether was like a brilliant transformation scene, and the meteor having passed away, the darkness of the night seemed to be in the last degree intense."

J. LLOYD BOZWARD.

A Correction.

IN the footnote, p. 152, second column, there is an unfortunate transposition for which myself more than the printers are to blame, which it is important to correct.

After the words "by Aristotle, Probl. I E 3 and Metaph. A 5" occur the words "which he attributes to Pythagoras . . . . on the nature of the Beast."

These words should have come at the end of the subsequent paragraph where I say that "Muhamad-al-Sharastani assigns *reasons* for regarding all the numbers up to 10 inclusive as perfect numbers."

It is these *reasons* which I speak of as being by him attributed to Pythagoras, &c.

I may take this opportunity of giving, as another example of the use of the New Nomenclature, the well-known *extended* Theorem of Fermat, which may be expressed by saying:

"Every number must divide the Fermatian of which the index is its *totient*, and the base any one of its *totitives*."

Athenæum Club, December 15. J. J. SYLVESTER.

ISOLATION OF FLUORINE.

ONE of the most difficult problems of modern chemistry has at last been satisfactorily solved. After three years of incessant labour, occasionally interrupted by temporary feelings akin to despair, M. Henri Moissan has at length isolated in considerable quantities that most baffling of elements—fluorine, and has been enabled to determine its principal properties. The experiments themselves are among the most interesting ever performed, and their details, as described by M. Moissan in the December number of the *Annales de Chimie et de Physique*, form the most fascinating reading. They must of necessity have been extremely costly, for by far the greater portion of the apparatus employed was constructed of platinum, and it is not often that one hears of a platinum tube 80 centimetres long and of $1\frac{1}{2}$ centimetre diameter being destroyed in each experiment, as happened in the earlier stages of these researches.

The isolation of fluorine has formed a worthy object of the attention of chemists ever since the first remarkable experiments of Sir Humphry Davy, who was rendered dangerously ill by being exposed to the corrosive fumes of hydrofluoric acid. Although Davy was not successful in obtaining free fluorine, yet he brought clearly to light the nature of hydrofluoric acid, and proved it to consist of hydrogen combined with an unknown but extremely active element—fluorine. The history of all the attempts which have since been made to effect the preparation of free fluorine might occupy a volume, and it will therefore only be necessary to refer to the later work of our countryman, Gore, who, in 1869, published his researches upon the electrolysis of hydrofluoric acid, and of certain fluorides, and left our knowledge of the acid itself in a most complete state. M. Moissan, working in the laboratory of M. Debray, now steps in and achieves the result so ardently sought after during the last eighty years—another example of the irresistible power of human perseverance.

In the light of the experience gained by former experimenters, it appeared that the action of a powerful electric current upon the compounds of fluorine with the non-metallic elements, such as hydrogen, phosphorus, and arsenic, would be most likely to yield the desired result; knowing also that fluorine must be an extremely energetic substance, it was absolutely essential to work at very low temperatures. Hence M. Moissan's first attack was made upon the fluorides of phosphorus and arsenic, but finding these to be practically impregnable, he diverted his attack, guided by certain indications afforded during his first attempt, upon hydrofluoric acid itself. Finding, however, that pure hydrofluoric acid is an exceptionally bad conductor of electricity, as has been stated by other workers—that even a current from fifty Bunsen cells would not pass through the liquid—he eventually, after several essays, succeeded in converting it into a conductor by dissolving in it a quantity of the double fluoride of potassium and hydrogen. On passing the current from twenty Bunsen cells through the now conducting medium, hydrogen immediately commenced to be evolved at the negative terminal, while fluorine was with similar rapidity evolved at the positive pole, and exhibited its tremendous activity upon everything that came near it: burning up hard crystalline silicon like tinder, setting fire to organic matter, and forming fluorides with incandescence with many other elements.

Having thus indicated the general course of these researches, it will no doubt be interesting to follow M. Moissan during the carrying out of his principal experiments.

The first series consisted in examining the action of electric induction sparks upon the gaseous fluorides of silicon, phosphorus, and arsenic. The gases were introduced into glass eudiometer tubes standing over mercury, and the spark was passed between two platinum wires connected with an induction-coil actuated by a few Grenet or Bunsen cells. On introducing dry silicon tetrafluoride, SiF_4, and passing sparks for an hour, no decomposition was effected, the result being discouragingly *nil*. Dry phosphorus trifluoride, PF_3, however, behaved quite differently, phosphorus being deposited upon the inner wall of the tube; but the fluorine liberated at once combined with the residual trifluoride to form the more stable pentafluoride, PF_5. Some time ago this pentafluoride of phosphorus was prepared by Prof. Thorpe, who also submitted it to the action of the induction-spark, unfortunately without effecting any decomposition. Precisely the same result has been arrived at by M. Moissan, using a 0·04m. spark; but on obtaining sparks 0·2m. long, a rapid etching of the walls of the glass tube occurred, and the meniscus of mercury entirely lost its brilliancy. After an hour's duration the experiment was concluded, and the apparatus allowed to cool, when it was noticed that the volume had diminished; moreover, the gas was found to have changed its properties, yielding a precipitate of silica in contact with water, while the residual gas consisted of the trifluoride of phosphorus. Hence $PF_5 = PF_3 + F_2$, which latter forms, with the glass, silicon tetrafluoride, and, with the mercury, fluoride of mercury. So here again the experiment was disappointing, and although fluorine was for the moment liberated, this method was certainly not suitable for the preparation of free fluorine.

Fluoride of arsenic, AsF_3, the next fluoride experimented upon, was first prepared by M. Dumas, who was severely injured in the experiment. It is a liquid which boils at 63° C., and may be easily maintained in a gaseous condition, by use of a steam jacket, and submitted to the action of the spark. It is, however, a most disagreeable substance to work with, as it produces most terrible sores when by any mischance it comes in contact with the operator's skin. On passing sparks through it for an hour, as in case of the pentafluoride of phosphorus, the platinum wires became covered with a black incrustation of arsenic, while the walls of the tube were strongly corroded. On testing the gas, it was found to contain a large quantity of silicon tetrafluoride mixed with a smaller quantity of free fluorine, which displaced sufficient iodine from a solution of potassium iodide to give a good coloration to several cubic centimetres of chloroform. Clearly, progress was being slowly made, though still far from the isolation of fluorine.

And now a remarkable experiment of a new type was performed. It had been noticed that, on passing an electric current through a platinum wire in an atmosphere of phosphorus trifluoride, the platinum fused owing to the formation of a fusible phosphide of platinum; at the same time the glass of the containing vessel was etched and the mercury attacked. So the experiment was repeated on a grander scale. A quantity of spongy platinum, previously washed with hydrofluoric acid and calcined, was placed in a platinum tube 80 cm. long, and of 1·5 cm. diameter; that portion of the platinum tube which required to be heated was incased in a second outer tube of glazed porcelain, so that between the two a current of nitrogen could be kept circulating, and so prevent access of furnace gases. The tube was then heated in a furnace, and pure hydrogen passed through it for some time to remove all other gases; afterwards pure nitrogen was substituted, and finally phosphorus trifluoride. After passing a short time, the current of fluoride was suddenly stopped with a most singular result: a partial vacuum was caused, owing to absorption by the platinum.

When, however, the current of trifluoride was passed more rapidly, a small quantity of pentafluoride was formed; the fluorine liberated, when the absorption of phosphorus by the platinum occurred, having combined with the trifluoride just as in the spark experiment. But, on examining the gas which passed out of the tube under these conditions, it was found to liberate iodine from potassium iodide, attack mercury, and etch glass. In fact, it was proved that free fluorine was liberated, and mostly absorbed by the platinum, causing the diminution of pressure on stopping the current, but being more or less carried away when the current was more rapid. The fluophosphide of platinum formed was found to contain only 70 to 80 per cent. of platinum, and the formation of this substance was so rapidly effected that every experiment required a new tube. The action of pentafluoride of phosphorus upon platinum was next tried, and with still more encouraging results. On sweeping the tube, heated in a coke blast-furnace, with a rapid stream of the pentafluoride for some minutes, then moderating the rapidity, and five minutes later again increasing the speed, the issuing gas was found to blacken solid potassium iodide by liberating free iodine, inflame phosphorus, and attack crystalline silicon, glass, and mercury. It was, in fact, free fluorine drowned in excess of trifluoride of phosphorus. This was a decided advance, and the outlook was becoming considerably more hopeful.

The next experiments were made with liquid fluoride of arsenic, AsF_3, a quantity of which was placed in a platinum crucible, which served as the negative electrode. A platinum wire, dipping into the liquid in the crucible, and reaching to within 5 millimetres of the base, served as the positive electrode. The current from three Grenet cells was then passed through the liquid, causing a deposition of arsenic upon the interior surface of the crucible, but no gas could be perceived at the positive pole. However, on dipping the platinum wire into a solution of starch paste and potassium iodide, blue striæ were at once formed in the solution, showing the presence of a condensed gas sheath of fluorine around the platinum wire. Following up this indication, the current from twenty-five Bunsen cells arranged in series was next employed, and immediately the deposition of arsenic commenced upon the walls of the crucible, while bubbles of gas were evolved around the platinum wire. Unfortunately the action soon ceased, owing to the bad conductivity of the liquid and of the thick deposit of arsenic. The wire, however, was strongly attacked. So attempts were next made to increase the conductivity of the fluoride by the addition of metallic fluorides, and it was soon discovered that the best results were obtained by use of the double fluoride of hydrogen and potassium, HF . KF. It was probably this discovery which led to the grand success with which these efforts have been finally crowned, for, as has been previously mentioned, it was by the electrolysis of this double fluoride that M. Moissan eventually succeeded in preparing free fluorine.

Before leaving the experiments upon arsenic fluoride, it may be mentioned that it was eventually electrolyzed in a continuous manner by use of seventy to ninety Bunsen cells, the arsenic liberated remaining in suspension in the liquid, instead of adhering to the tube, but the bubbles were rapidly seen to diminish in size in passing through the liquid, and scarcely a trace of gas escaped; instead of permitting its isolation, the fluorine preferred to form a new fluoride, the pentafluoride of arsenic, thus once more baffling the ingenious experimenter.

But success was not now far away. The wonderful manner in which the double fluoride of potassium and hydrogen increased the conductivity of arsenic fluoride determined M. Moissan in employing it for the same purpose in an attempt to electrolyze pure anhydrous hydrofluoric acid. Faraday long ago showed that the electric current will not pass through the anhydrous acid, and Gore more recently came to the same conclusion. The current from fifty Bunsen cells was found by M. Moissan to be absolutely powerless to penetrate the acid used in these later experiments. But, on dissolving a few fragments of the double fluoride HF . KF in the acid, the current at once passed freely, and the experiment thus became possible. The apparatus used in the first attempts with this mixture consisted of a platinum U-tube, of which each branch was closed by a paraffined cork, through which the rods of platinum forming the poles were passed. Upon each branch, just above the level of the liquid and beneath the cork, was soldered a little platinum delivery-tube to lead off the gases evolved. As hydrofluoric acid boils at 19°·4 C., the apparatus was immersed in a bath of methyl chloride, which boils at −23°, but which could be reduced in temperature to −50° by driving through it a current of dry air. Hence the electrolysis could be conducted without fear of the gaseous products being drowned in excess of vapour of hydrofluoric acid, and the activity of the liberated fluorine was at the same time moderated. On passing the current, a gas was at once produced at each electrode, a regular evolution of hydrogen at the negative pole, and a continuous disengagement of gas at the positive pole. But still affairs were not satisfactory: crystalline silicon did not take fire when held in the gas coming off from the positive pole; so the apparatus was taken to pieces an hour later, in order, if possible, to find a clue to the source of failure. The paraffined cork at the negative branch was intact, but, behold the mischief, the other was carbonized to the depth of a centimetre; so the liberated fluorine had extracted hydrogen out of the cork, and passed on as hydrofluoric acid. The positive platinum rod was also much corroded. Closely-fitting stoppers of fluor-spar were next tried, coated with melted

gutta-percha, but the latter again soon melted on passing the current, and was put *hors de service*. Gum-lac and many other substances were tried, but all to no purpose, and much precious time was lost. Finally, however, the difficulty was overcome by using stoppers of fluor-spar, carefully inserted in hollow cylinders of platinum carrying fine screw threads upon their outer surfaces, which engaged with corresponding threads upon the interior surfaces of the two branches of the U-tube. The platinum rods passed through the axis of each cylinder of fluor-spar: the rods themselves were of square section, of 2 millimetres side and 12 centimetres long, and passed to 3 millimetres from the base of the U-tube; they were made of irido-platinum, containing 10 per cent. iridium, which is less attackable than pure platinum. The U-tube simply consisted of a platinum tube, bent twice at right angles, 1·5 centimetre diameter and 9·5 centimetres high, and was fitted with side tubes and immersed in methyl chloride as before.

The pure anhydrous hydrofluoric acid, which was the next necessity, was prepared in the following manner. A known volume of commercial acid was treated with sufficient potassium carbonate to neutralize about a quarter of it, and then distilled in a leaden retort over an oil bath at 120°. At this temperature the fluosilicate of potassium, formed from the hydrofluosilicic acid, contained as impurity in the commercial acid, was not decomposed, and the distillate was therefore free from silica. This distillate was then divided into two parts, and one half, saturated with pure potassium carbonate, forming neutral potassium fluoride, was then added to the other half, and transformed into HF . KF. The double fluoride was then dried at 100°, and afterwards kept for some days in the vacuous receiver of an air-pump, containing also strong sulphuric acid and a few sticks of fused potash. When absolutely dry it fell to powder, and was then ready for the preparation of hydrofluoric acid, which was always freshly prepared immediately before each experiment. The dry fluoride was in each case introduced into a recently ignited platinum retort, and maintained at a moderate heat for some time so as to commence the decomposition slowly; the first portions of distillate were rejected, as they would contain the last traces of water. The platinum receiver was then adapted and surrounded by ice and salt; on heating the retort more strongly, pure hydrofluoric acid condensed in the receiver as a limpid liquid boiling at 19°·4, very hygroscopic and fuming in the air.

While the preparation of the acid was in progress, the U-tube and electrodes were drying at 120°. From 6 to 7 grammes of the dry double fluoride were now introduced into the apparatus, the stoppers were screwed in and covered with gum lac. The whole was then fixed in the methyl chloride bath, and, until the introduction of the acid, the delivery-tubes were connected with desiccators containing fused potash. A constant supply of methyl chloride at $-23°$ was maintained in the outer cylinder, as a slight rise of temperature allowed of the volatilization of some of the acid. About 15 to 16 grammes of the anhydrous hydrofluoric acid were then gently aspirated into the apparatus, and the current from twenty Bunsen cells allowed to pass, when immediately a regular evolution of gas occurred at each pole. At the negative pole pure hydrogen was evolved, which burnt with its characteristic flame, forming water. At the positive pole was liberated a colourless gas of penetrating and very disagreeable odour, somewhat resembling that of hypochlorous acid, and rapidly irritating the mucous membranes of the throat and eyes. It was no other than pure fluorine itself. All the trouble, all the expense, and all the disappointments were repaid. It must indeed have been a supreme moment for M. Moissan.

In order to study its action upon solids, they were placed in small glass tubes, and brought near to the orifice of the platinum delivery-tube at the positive side. The test was generally repeated, holding the solids in small platinum capsules.

Sulphur, brought thus near the orifice, at once melted and inflamed; selenium behaved in like manner; as did also tellurium, with incandescence, forming fumes and becoming coated with a solid fluoride.

Phosphorus at once took fire, forming tri-, penta-, and oxyfluorides. Powdered arsenic and antimony combined with incandescence, the former yielding drops of AsF_3.

A fragment of iodine placed in the gas combined with production of a pale blue flame; in an atmosphere of iodine vapour fluorine itself burnt with a similar flame. Vapour of bromine lost its colour and the combination was sometimes accompanied by detonation.

Cold crystalline silicon at once became incandescent, and burnt with great brilliancy, sometimes with scintillations. On closing the little tubes containing it with the thumb and opening under water, the silicon tetrafluoride formed was absorbed and decomposed with precipitation of silica. Any undecomposed silicon was found to have been fused.

Debray's adamantine boron also burnt in the gas, becoming incandescent and giving off fumes.

Fluorine has a most extreme affinity for hydrogen; they combine in the dark with explosion. In one of the experiments the electrolysis was allowed to continue several hours, so that eventually the small quantity of undecomposed acid remaining in the U-tube was insufficient to keep the two gases apart; the experimenters were consequently suddenly startled by a violent detonation. The hydrogen and fluorine had combined in the dark at the low temperature of $-23°$. The same detonation was afterwards brought about on a smaller scale by reversing the current. On bringing the wide-mouthed delivery-tube of a hydrogen generator near the orifice, the detonation at once occurred, and the hydrogen inflamed.

Metals are all attacked with more or less energy by fluorine, forming fluorides. Cold sodium and potassium were at once rendered incandescent. Calcium, magnesium, and aluminium acted similarly, in a more modified manner, becoming incandescent when slightly warmed. Powdered iron and manganese, on gently warming, burnt with bright scintillations; lead was attacked in the cold, and tin at a slightly elevated temperature. Mercury, as suspected, entirely absorbed the gas, forming yellow protofluoride. Silver at a gentle heat became coated with a beautiful satin-like fluoride, soluble, unlike the chloride, in water. Gold and platinum at 300°-400° became coated with their respective fluorides, which were decomposed again at a red heat, with evolution of free fluorine.

Perhaps the strongest evidence of the intense chemical activity of fluorine is exhibited in its action upon cold potassium chloride: the chlorine was at once expelled, filling the air with its disagreeable odour, and was identified by the usual chemical tests. Chlorine was also expelled from its combination with carbon in carbon tetrachloride.

All organic compounds are violently attacked by fluorine: a piece of cork at once carbonized and inflamed; alcohol, ether, benzene, and turpentine took fire immediately in contact with it.

Glass, as might have been expected, is at once corroded by fluorine; some very delicate experiments were carried out with perfectly dried glass, with the same result.

Many other reactions, all interesting and all showing the immense energy with which the atoms of fluorine are endowed, were performed, but one especially ought to be noticed, viz. the action of fluorine upon water. It is a singular fact that, whenever oxygen is liberated in the cold, there is a great tendency to form ozone: hence when fluorine is attempted to be collected over water, the gas collected is not fluorine, but ozonized oxygen; water is decomposed by the fluorine forming hydrofluoric acid,

while the oxygen is set free, and a considerable quantity of it is converted into the more condensed form of ozone.

On taking the apparatus to pieces after each experiment, the hydrofluoric acid remaining was found to contain a small quantity of platinum fluoride in solution, and a black mud consisting of a mixture of iridium and platinum in suspension. The negative electrode was not attacked, but the platinum rod forming the positive pole was eaten away to a point, so that one rod only served for two experiments. The average delivery of gas was about 1·5 to 2 litres per hour.

With regard to the chemical processes involved in the electrolysis, it appears probable that potassium fluoride is first decomposed into fluorine, which is evolved at the positive pole, and potassium, which decomposes hydrofluoric acid, liberating its equivalent of hydrogen at the negative pole, and re-forming potassium fluoride, which may again be electrolyzed. Hence a small quantity of the double fluoride can serve for the decomposition of a comparatively large amount of hydrofluoric acid.

The double fluoride HF . KF is very soluble in hydrofluoric acid, forming a crystallizable compound, richer in hydrofluoric acid than HF . KF, and which gives off no acid vapour at the boiling-point of the anhydrous acid, 19°·4. It is this compound which one ought to seek to obtain for electrolysis, as it is very soluble in excess of acid, forming a liquid of good conductivity.

The double fluoride HF . KF itself was finally electrolyzed by M. Moissan. It fuses at 140° to a colourless liquid which is quite suitable for electrolysis. The experiment was performed, as before, in a platinum U-tube, and, on passing the current, fluorine was again liberated at the positive pole, and at once set fire to crystalline silicon; but the platinum was strongly attacked, so the experiment was stopped in order to save the tube. On plunging a couple of platinum wires connected with the battery into a quantity of the fused double fluoride contained in a platinum crucible, gas was evolved in abundance at each pole, and on bringing the wires in contact, even in the dark, detonation occurred, owing to the combination of the evolved hydrogen and fluorine. At the same time the platinum wire from which the fluorine was evolved was almost entirely eaten away.

In concluding these remarkable researches, which have happily terminated so successfully, M. Moissan discusses very fully the question of the identity of the gas liberated at the positive pole with the element fluorine; and there can be no doubt that he has completely proved this identity, at the same time showing that fluorine occupies the place of honour as the most intensely active chemical element with which we are at present acquainted, and that it assumes its rightful position, theoretically destined for it, at the head of the group of halogens.

A. E. TUTTON.

TIMBER, AND SOME OF ITS DISEASES.

I.

ON carefully examining the clean-cut end of a sawn log of timber, it is easy to convince ourselves of the existence of certain marks upon it, which have reference to its structure. These marks will vary in intensity and number according to the kind of tree, the age at which it is felled, and some other circumstances, which may be overlooked for the present; but in a given case it would be possible to observe some such marks as those indicated in Fig. 1. In the specimen chosen there is a nearly central spot, the pith, around which numerous concentric lines—the "annual rings"—run. Radiating from the pith towards the periphery are cracks, the number, and length, and breadth of which may vary according to the time the log has been exposed to the weather, and other circumstances; these cracks are due to the contraction of the wood as it "shrinks," and they coincide with medullary rays, as lines of weakness. Between these cracks are to be seen numerous very fine radiating lines indicating the course of the uninjured medullary rays, which again will vary in distinctness, &c., according to the species of timber.

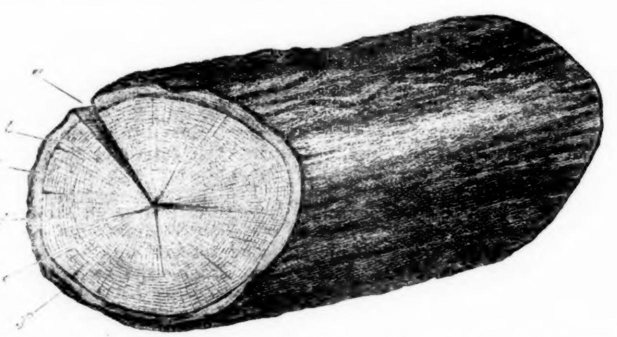


FIG. 1.—A log of timber, showing radial cracks after lying exposed for some time. *a*, a large crack extending from pith to circumference; *b*, the cortex; *c*, medullary ray; *d*, cambium; *e*, annual ring; *f*, outer bark, proper. Reduced.

This log of wood, with its annual rings and medullary rays, is clothed by a sort of jacket, consisting of cork and softer tissues, and termed the cortex, or, more popularly, the "bark" (an unfortunate word, which has caused much trouble in its time). The largest of the cracks is seen to traverse the whole radius of the face of the wood from centre to circumference, and also to pass through the cortex, which gapes widely.

The remaining cracks, however, stop short at a line which marks on the one hand the inner face of the cortex, and on the other the outer face of the wood: this line also represents the cambium, a thin sheet of generative tissue which remains after giving rise to practically the whole of the wood (a very little in the centre excepted) and cortex visible in the woodcut. Since we are not concerned with the cortex and bark at present, it will be convenient to regard the log as "barked," and only deal with the wood or timber itself, in the condition to which the woodman reduces it after removing the cortex with certain implements.

If now we split such a log as Fig. 1 along the line of the big crack, neatly and smoothly, the well-known "grain" so often observed on planks of wood will come into view, and it will be noticed that the lines which mark the "grain" are continuations of the lines which mark

the annual rings, as shown in Fig. 2, which represents on a larger scale a segment such as could be cut from a log in the way described. It is clear from comparison of what has been said, and of the two figures, that the "annual rings" are simply the expression in cross-section of cylindrical sheets laid concentrically one over the other, the outermost one being that last formed. But on examining the medullary rays in such a piece of timber as that in Fig. 2, it will be noticed that they also are the expression of narrow radial vertical plates which run through the concentric sheets: the medullary rays are in fact arranged somewhat like the spokes of a paddle-wheel of an old steamer, only they differ in length, breadth, and depth, as seen by comparing the three faces of the figure. It is to be noticed that the medullary rays consist of a different kind of tissue from that which they traverse, a fact which can only be indicated in the figure by the depth of shading. It is also to be observed that the "annual rings" show differences in respect to their tissue, as marked by the darker shading near the boundary lines on the outer margin of each ring. In order to understand these points better, it is necessary to look at a piece of our block of timber somewhat more closely, and with the aid of some magnifying power. For the sake of simplicity it will be convenient to select first a piece of one of the timbers known as "deal" (firs, pines, &c.), and to observe it in the same direction as we commenced with, *i.e.* to examine a so-called transverse section.

The microscope will show us a figure like that in the woodcut (Fig. 3). There are to be seen certain angular openings, which are the sections of the long elements technically called *tracheides*, shown in elevation in Fig. 4. It will be noticed that whereas along some parts of the section these openings are large, and as broad in one direction as in the other, in other parts of the section the openings are much smaller, and considerably elongated in one direction as compared with the other. The band of small openings naturally looks more crowded and therefore darker than the band of larger openings, and it is to this that the differences in the shading of the annual rings in Fig. 2 are due. But it is not simply in having larger lumina or openings that the dark band of tracheides is distinguished from the lighter one: the walls of the tracheides are often also relatively thicker, and obviously a cubic millimetre of such wood will be denser and contain more solid substance than a cubic millimetre of wood consisting only of the larger, thin-walled tracheides. It is equally obvious that a large block of wood in which the proportion of these thick-walled tracheides with small lumina is greater (with reference to the bands of thin-walled tracheides) will be closer-grained, and heavier, than an equal volume of the wood where the thin-walled tracheides with large lumina predominate.

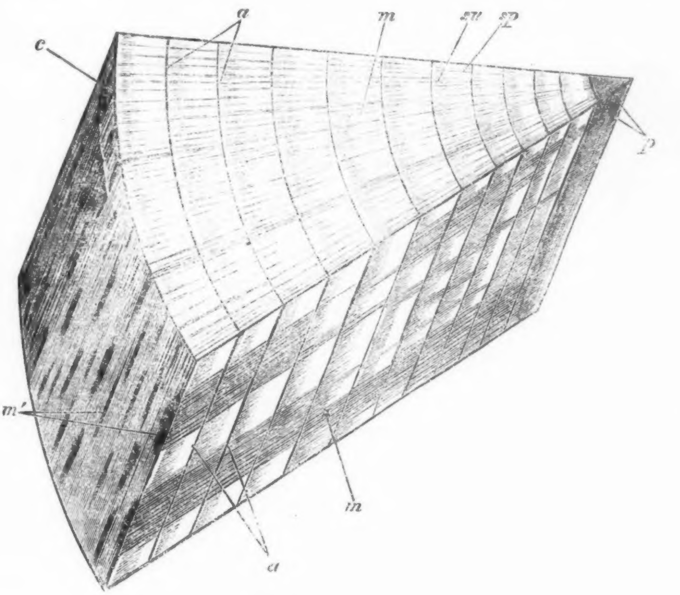


FIG. 2.

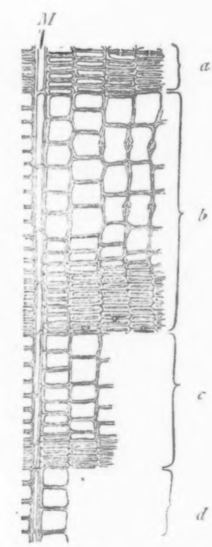


FIG. 3.

FIG. 2.—Portion of segment of wood from a log such as Fig. 1, supposed to be slightly magnified. *a*, annual ring; *m*, medullary rays; *m'*, the same in vertical section; *c*, the boundary line between one annual ring and another; *sw*, autumn wood; *sp*, spring wood; *p*, the pith.

FIG. 3.—Portions of four annual rings from a thin transverse section of the wood of a Conifer, such as the Spruce-fir. *M*, a medullary ray; *b* and *c* show the entire breadth of two annual rings; *a*, autumn wood of an annual ring internal to *b* (and therefore older than *b*); *d*, spring wood of an annual ring external to *c* (and therefore younger than *c*). Bordered pits are seen in section on some of the tracheides. Magnified about 100 times.

Returning now to the section (Fig. 3), it is to be observed that the differences in the zones just referred to enable us to distinguish the so-called "annual rings." The generally accepted explanation of this is somewhat as follows. In the spring-time and early summer, the cambium-cells begin to divide, and those on the inner side of the cylinder of cambium gradually become converted into tracheides (excepting at a few points where the cells add to the medullary rays), and this change occurs at a time when there is (1) very little pressure exerted on the inner parts of the trunk by the cortex and corky bark, and (2) only comparatively feeble supplies are derived from the activity of the leaves and roots, in the still cool weather and short days with little sunlight. In the late summer, however, when the thickened mass of wood is compressed by the tightened jacket of elastic bark which it has distended, and the long, hot, bright sunny days are causing the numerous leaves and roots to

supply abundance of nutriment to the growing cambium-cells, it is not surprising that these cells cannot extend themselves so far in the radial direction (*i.e.* in a line towards the centre of the compressed stem), and that their walls are thickened by richer deposits of woody material supplied quickly to them.

As the winter approaches, the cambium ceases to be active, and it then remains dormant for several months. When its cells are awakened to renewed growth and division in the following spring, they at once begin to form the tracheides with thin walls and large lumina, and it is the sharp contrast thus displayed between the newly-formed tracheides with thin walls and large lumina, and the compressed denser ones on which they suddenly abut, that produces the impression of the "annual ring."

It is now time to attempt to give some clearer ideas of what this "cambium" is, and how its cells become developed into tracheides. But first it is necessary to point out that each tracheide is a long, more or less tubular and prismatic body, with bluntly tapering ends, and the walls of which have certain peculiar markings and depressions on them, as seen in Fig. 4. We cannot here go into the important signification and functions of these markings and depressions however, since their study would need an article to themselves. It must suffice for the present to state that the markings have reference to the minute structure of the cell-walls, and the depressions are very beautiful and complicated pieces of apparatus to facilitate and direct the passage of water from the cavity of one tracheide to that of another. Now, the cambium is a thin cylindrical sheet of cells with very delicate walls, each cell having the form of a rectangular prism with its ends sharpened off like the cutting edge of a carpenter's chisel: this prism is broader in the direction coinciding with the plane of the sheet of cambium—*i.e.* in the tangential direction, with reference to the trunk of the tree—than in the

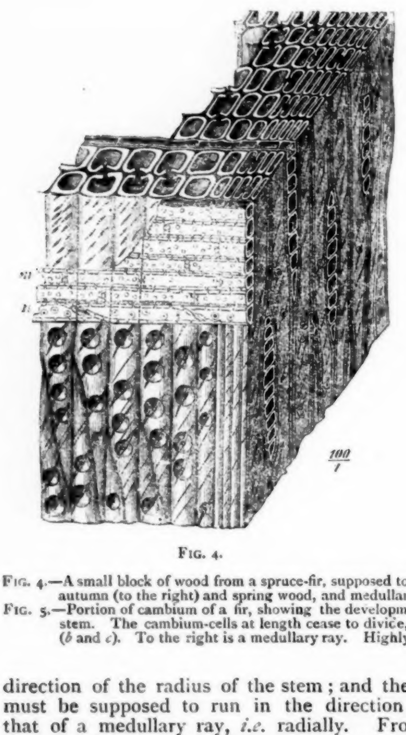


FIG. 4.

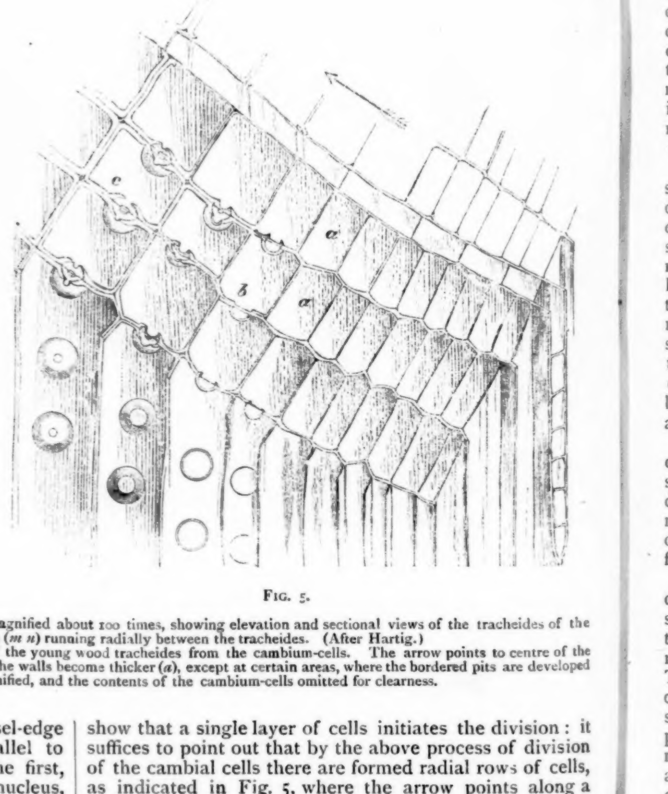


FIG. 5.

FIG. 4.—A small block of wood from a spruce-fir, supposed to be magnified about 100 times, showing elevation and sectional views of the tracheides of the autumn (to the right) and spring wood, and medullary rays (*m n*) running radially between the tracheides. (After Hartig.)

FIG. 5.—Portion of cambium of a fir, showing the development of the young wood tracheides from the cambium-cells. The arrow points to centre of the stem. The cambium-cells at length cease to divide, and the walls become thicker (*a*), except at certain areas, where the bordered pits are developed (*b* and *c*). To the right is a medullary ray. Highly magnified, and the contents of the cambium-cells omitted for clearness.

direction of the radius of the stem; and the chisel-edge must be supposed to run in the direction parallel to that of a medullary ray, *i.e.* radially. From the first, each cambial cell contains protoplasm and a nucleus, and is capable of being nourished and of growing and dividing. It is only at or near the tips of the branches, &c., that these cambium-cells are growing much in length, however; and in the parts we are considering they may be for the most part regarded as growing only in the radial direction; more rarely, and to a slight extent, in the tangential direction also, as the circumference of the cylinder enlarges. After a cambial cell has extended its walls by growth in the radial direction to a certain amount, a septum or division wall arises in the longitudinal tangential plane, and two cells are thus formed in place of one: this process of division may then be repeated in each cell, and so the process goes on. This is not the place to lay stress on certain facts which show that a single layer of cells initiates the division: it suffices to point out that by the above process of division of the cambial cells there are formed radial rows of cells, as indicated in Fig. 5, where the arrow points along a radius towards the centre of the stem. It is true such radial rows of cells are also developed in smaller numbers towards the outside of the cambium cylinder (*i.e.* to add to the cortex), but we are only concerned with the wood, and therefore only regard those cells which are developed on the inside (*i.e.* towards the centre of the stem). After a time the oldest of these cells (*i.e.* those nearest the centre of the stem) cease to divide, and undergo changes of another kind: the process of division is still going on in the younger ones, however; and so the radial rows are being extended by additions of cells at their outer ends. Of course, this is normally proceeding along the whole area of the cylindrical sheet of cambium, and therefore over the whole of the stem and roots, with their branches.

Confining our attention to one of the innermost, oldest cells of the cambium, which has ceased dividing (*aa* in Fig. 5), we find that it enlarges somewhat in the radial direction, and then its hitherto very thin walls become thicker; in fact, the protoplasm in its interior absorbs food-materials, and changes them into a peculiar substance which it plasters or builds on to the inner sides of the cell-wall, so to speak, until the wall is much thicker. This thickening process is withheld at certain places only—the thin depressions already referred to. Two chief changes result now: (1) the whole of the living contents of the young wood-cell gradually become used up, and eventually disappear without leaving any trace; and (2) the thickening substance built on to the inside of the walls undergoes changes which convert it into true wood-substance—in botanical language, the walls become lignified. The cells *b* and *c* in Fig. 5 illustrate what is meant.

During all these changes, which occupy several or even many hours or days, according to circumstances, it will be observed that the definitive shape of the cell is gradually completed, and then alters very little: the prismatic cambium-cell has become a prismatic tracheide, with thicker, lignified walls, and containing air and water (with minute quantities of mineral substances dissolved in it) in place of protoplasm and nutritive substances. It is not necessary here to speak of other and more subtle changes which cause slight displacements, &c., of these cells.

If I have succeeded in making the chief points in this somewhat complicated process clear, there will be little difficulty in explaining what occurs in other parts of the cambium-cylinder. The cambium-cells which happen to stand in the same radial row as the cells of a medullary ray, simply go on being converted into cells of the medullary ray, instead of into tracheides; cells which differ from the tracheides chiefly in retaining their living contents and nutritive materials—*i.e.* substances like starch, proteids, sugars, &c., which are used as food by the plant. Again, those cells of the cambium which are divided off on the outer side of the cylinder (they are always fewer in number) are gradually transformed into elements of the cortex, and finally enter into the composition of the bark proper.

Now and again, but much more rarely, a radial row of cambial cells which, from their position, it would appear should be converted into tracheides of the wood, alter their destiny, so to speak, and become the originators of a new medullary ray. But I must pass over these and some other minor peculiarities, and refer to the illustrations for further details.

If now, instead of a log of deal, or coniferous wood, we direct attention to the timber of a dicotyledonous tree, such as the oak, ash, beech, chestnut, poplar, &c., the differences in detail will not be found very great in relation to the broad features here under consideration. Turning again to Fig. 1, it would be possible to select a cut log of any of these timbers which presented all the salient characters there exhibited. The bark would present external differences in detail—such as in roughness, colour, thickness, &c.—but it could still be described, as before, as a more or less corky jacket around the whole of the wood: the cut face would show the timber marked by more or less numerous and prominent "annual rings," traversed by smaller or larger medullary rays, radiating from the central pith, and passing across the cambium to the cortex. Moreover, cracks would be apt to form on exposure, as before; the opening occurring along the lines of medullary rays—lines of weakness.

Again, if we cut a segment of the wood, like Fig. 2, the chief features would present themselves as there shown, and the lines of demarcation indicating the annual rings would be found to be due to the sharp contrast between the spring wood and the autumn or summer wood, as before.

On closely examining a transverse section of such a piece of timber, however, we should find differences which at first sight appear profound, but which on reflection and comparison turn out to be of more relative significance, from the present point of view, than might be expected.

Selecting a given example, that of the beech for instance, the first difference which strikes us (Fig. 6) is a number of relatively very large openings on the transverse section: these are the vessels—pitted vessels—long tubular structures which are not formed by the cambium of the conifers. Between these vessels are much more numerous elements with very small lumina and thick walls: the latter are the wood-fibres proper, and have to be technically distinguished from the apparently somewhat similar wood-tracheides of the pines, firs, &c. Here and there, scattered in small groups, are certain rows of shorter cells, which, however, are not very numerous in the beech: they are called wood-parenchyma (Fig. 6, *wp.*), and occur particularly in the vicinity of the vessels.

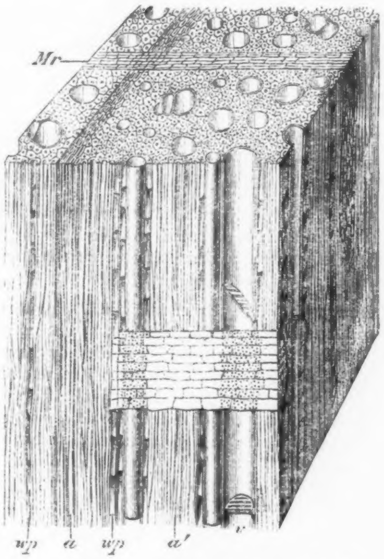


FIG. 6.—A piece of wood from a dicotyledonous tree (beech), supposed to be magnified about 100 times. *Mr*, a medullary ray running across the transverse section: the dark band crossed by this ray is the autumn wood (*a*), formed of closely-crowded wood-fibres and tracheides; *v*, a large vessel in section: others are seen also—they are smaller and fewer towards the autumn wood; *a'*, wood-fibres, of which most of the timber is compose d; *wp*, wood-parenchyma cells.

It is beside the purpose here to describe in detail the histology of the beech-wood, and reference may be made to the figures for further particulars. It may suffice to say that all the elements—cells, fibres, and vessels—are formed as before by the gradual development of cambium, cells; and the same is true, generally, of the medullary rays here that is true of those of the pines and firs, &c.

Attention is to be directed to the fact, which is here again evident, that the line of demarcation between any two "annual rings" is due to the sudden apposition of non-compressed elements upon closely-packed and apparently compressed elements: the latter were formed in the late summer, the former in the spring. Moreover, the spring wood usually contains more numerous vessels, with larger lumina than the autumn wood: in this particular case, again, the fibres of the autumn wood are darker in colour. It should be stated, however, that many dicotyledonous trees show these peculiarities much more clearly than the beech; others, again, show them less clearly.

Now it is obvious that, other things being equal, the spring wood, with its more numerous and larger vessels, and its looser tissue generally, will yield more readily to lateral pressure and strains than the denser autumn wood; and the like is true of the pines and firs—the closely-packed, thick-walled tracheides of the autumn wood furnish a firmer and more resistant material than the larger, thinner-walled tracheides of the spring wood. To this point we shall have to return presently.

H. MARSHALL WARD.

(*To be continued.*)

NOTES.

WE deeply regret to announce the death of Prof. Balfour Stewart, one of our most eminent men of science. Last Friday morning he left the Owens College, apparently in his usual health and in good spirits, intending to spend the holidays at his Irish home. He died on Sunday night. Next week we shall have something to say about his character and work.

THE death of Carl Langer, the well-known Professor of Anatomy at the University of Vienna, is announced. He was in his sixty-eighth year.

DR. ARTHUR FARRE, F.R.S., died on the 17th inst., in his seventy-seventh year. He was elected a Fellow of the Royal Society in 1839.

THE Royal Society has been admitted to the number of those public bodies to which is conceded by prescription or otherwise the privilege of presenting their addresses to the Sovereign on the throne.

THE Curatorship of the Natural History Department of the Science and Art Museum, Dublin, rendered vacant by the resignation of Mr. A. G. More, has just been filled by the promotion of Dr. R. F. Scharff, who had been one of the assistants in the Museum for some months. Dr. Scharff has already proved himself to be a diligent student of zoology in Edinburgh, where he took the degree of Bachelor of Science. In London he studied under Prof. Ray Lankester, and worked in the British Museum for some time under the Director, Prof. Flower, F.R.S., and he obtained the degree of Doctor of Philosophy at Heidelberg University.

MR. JOHN M. THOMSON has been appointed to the Chair of Chemistry in King's College, vacant through the death of Prof. Bloxam.

AT the Central Institution, Exhibition Road, South Kensington, Dr. A. K. Miller, Demonstrator and Assistant in the Chemical Research Laboratory, will deliver, during the spring term, a course of ten lectures on the chemistry of oils and fats. The course will be delivered on Mondays at 4 p.m., and will begin on January 23, 1888.

THE third annual meeting of the American Association for the Advancement of Physical Education was held at Brooklyn on November 25. It was well attended. Papers were read by Prof. Edward Hitchcock, of Amherst College, who presided; by Prof. E. H. Fallows, of the Adelphi Academy; and by Prof. J. W. Seaver, of Yale College.

Science (December 9, 1887) notes, as a fact which may be of interest to Americans, that in England the point of view of those who argue in favour of technical education is almost exclusively the economic. "But little is heard," it says, "of the educational nature of manual training." Speaking of the state of things in the United States, *Science* says:—"There is now, as is well known, a very general movement throughout this country in favour of what is known as manual training in education. After much misapprehension and tedious explanation, the leaders of this movement have finally managed to make the educational public understand that they advocate manual training mainly for its educational value, and only incidentally for the economic benefits which will undoubtedly flow from it."

THE twentieth annual meeting of the Kansas Academy of Science was held in the Capitol Building, Topeka, on October 26, 27, and 28. *Science* says that there was an excellent attendance of members, but that the local attendance was not quite equal to that of last year. The papers read, according to *Science*, were unusually valuable. The annual meeting next year will be held in Wichita, in October.

THE tenth general meeting of the German Society of Analytical Chemists was held at Frankfurt, on November 30. Dr. Schmitt, of Wiesbaden, was President.

THE tenth meeting of the German Geographical Society will be held at Berlin next Easter. In future the meetings will be held only once in two years.

FIFTY shocks of earthquake are reported to have occurred at Silveric, in Dalmatia, on November 29. On the same day, at 7.30 a.m., severe shocks occurred at Oran, Mascara, and Relizante, in Algeria.

ON the evening of November 21, from 8.30 p.m. to about 9, a remarkable luminous phenomenon, viz. a broad band of light right across the sky, was seen throughout the whole of central and southern Sweden. It caused much speculation, chiefly on account of its luminous immobility. Dr. N. Ekholm, of the Upsala Meteorological Observatory, and well known for his researches on the aurora borealis at Spitbergen, has now pronounced the phenomenon to be a so-called auroral band. Dr. Ekholm states that such bands are very uncommon in Sweden, but that they are often seen at Spitzbergen. He saw the phenomenon during a journey from Stockholm to Upsala, at 8.45 p.m., and noted its position. The band ran then just north of the northernmost stars in Orion, through Aldebaran, then a little south of the Pleiades, further through the Ram, and then a little north of the two southernmost stars in the square of Pegasus. He calculates its height above the earth at about 80 miles, its zenith being perpendicular above the two provinces of East and West Gothia. The bands moved from north to south at the rate of about 50 metres per second. In Upsala it seemed south of the zenith. Dr. V. C. Gyllenskiöld made similar observations at Upsala. Dr. Ekholm invites all who may have observed the phenomenon to communicate their observations to him in the interests of science.

ON the afternoon of November 26, at 4.30, a splendid meteor was seen at Laurvik in the Christiania fjord. It went from east to west, and apparently low in the horizon. In spite of the moonlight its tail was visible for some seconds afterwards.

ONE morning last week, the Teusfjord, a little to the north of Bergen, on the west coast of Norway, was covered with ice three-quarters of an inch thick, as far as the eye could reach. Ice, in consequence of the influence of the warmth of the Gulf Stream, has hitherto been unheard of on the west coast of Norway.

Symons's Monthly Meteorological Magazine for December contains an investigation of what was reported in the newspapers to have been an earthquake-shock in Central England on November 20 last. At the more western stations the reporters spoke chiefly of noise, and at the eastern ones of earth tremor. From evidence collected, it appears that the disturbance, as Mr. H. G. Fordham pointed out in NATURE last week (p. 151), was caused by the explosion of a large meteor. Further particulars

are requested, especially as to the locality where the meteor burst, which seems likely to have been between Thame and Abingdon.

THE Pilot Chart of the North Atlantic Ocean for December reports the occurrence of two interesting phenomena. (1) The formation of a very large waterspout on October 6 in latitude 39¼° N., longitude 69° W., during a thunder squall. The lower end of the spout did not reach the surface of the ocean. Water could be seen rushing down through the centre of the funnel and ploughing up the surface of the sea to a height of about 50 feet. (2) One of the rare and inexplicable cases of globular lightning. On November 12, at midnight, near Cape Race, a large ball of fire seemed to rise out of the sea to a height of about 50 feet, coming against the wind close up to the ship, and then running away to the south-east, lasting altogether about five minutes.

THE Meteorological Report published for the year 1886 by the Surveyor-General of Ceylon shows that rainfall observations are now taken at eighty-three stations. General observations are made at sixteen stations. The Report contains a map showing the mean annual rainfall of the island, and a diagram of the mean monthly fall at the principal stations. An important discussion of the Ceylon rainfall observations will be found in the Quarterly Journal of the Royal Meteorological Society for October last.

THE Russian Government does good service to meteorology by publishing observations taken for several hours daily on some selected cruises of its men-of-war. A volume has just been issued containing the observations of three such voyages, being Nos. 52-54 of the series. The information is rendered more available for ready use by the weather observations being expressed in the international symbols, and by the data being printed on one side only, to allow of being cut up and pasted in districts as required.

IT is reported from India that, in connection with a plan for improving the system of storm-warnings, new meteorological stations are to be opened, on the Coromandel coast, at Bimlipatam, Nellore, and Cuddalore, and one on the Burmah coast, probably at Tavoy. Mr. Elliott, Superintendent of the Bengal Meteorological Department, was to leave on an inspection tour to visit the coast stations, and to select sites for the new observatories.

THE *Observatory* will in future be edited by Mr. Turner, of Greenwich Observatory, and Mr. Common, of Ealing.

A FLORA of Hertfordshire by the late Alfred R. Pryor, edited by Mr. B. Daydon Jackson, with notes on the geology, climate, and rivers of the county, by Mr. John Hopkinson, will be published in a few days by Messrs. Gurney and Jackson, Mr. Van Voorst's successors. The book will consist of about 600 pages with a map.

THE twenty-third annual volume of the *Zoological Record* will be issued shortly. This valuable book of reference, which was established by Mr. Van Voorst, under the editorship of Dr. Günther, has been for some years supported by an Association. It is now taken over by the Zoological Society. Messrs. Gurney and Jackson will continue to publish the volumes.

MESSRS. GEORGE PHILIP AND SON have in the press, and will shortly publish, "Emin Pasha in Central Africa: Letters and Journals," collected and annotated by Dr. G. Schweinfurth, Dr. Ratzel, Dr. G. Hartlaub, and Dr. Felkin. The work has been translated from the German by Mrs. Felkin. It is illustrated with a portrait, and with two maps specially compiled by E. T. Ravenstein.

A SIXTH edition of Prof. Alleyne Nicholson's "Introductory Text-book of Zoology" (Blackwood) has just been issued. The book is intended for the use of junior students. It has been thoroughly revised, and the author explains that the general arrangement of certain of the larger groups of animals has been altered in accordance with the views now most generally accepted by naturalists. Some of the illustrations have been changed, and a few new engravings have been added.

WE have received from Mr. F. Enock some "Autocopyist" pen-and-ink sketches of bodies and parts of insects, together with examples of the prepared mounts of the objects delineated. The latter call for no special comment. The drawings, however, are exceedingly clear and well printed, scrupulously accurate, and highly commendable. The admiration of the beautiful in Nature must precede the study of the more useful; and, this being so, we can heartily recommend these drawings to the legion of microscopical *dilettanti*. Mr. Enock is practical in his work in that he introduces the Hessian fly, together with a sketch of the infected barley. By way of giving the brief notes which accompany the sketches an authoritative air, he introduces occasional bibliographical references. As pertaining to the aforenamed pest, an important paper by Prof. Fream, read before the British Association this autumn, and duly reported in these pages, may be recommended to Mr. Enock's notice.

M. VAYSSIÈRE, of Marseilles, has begun what promises to be an important publication—an atlas of the anatomy of invertebrates. The first quarter of the book has already been issued.

MESSRS. MACMILLAN AND CO will publish early in January a revised and extended edition of the well-known "Practical Biology" of Prof. Huxley and Dr. H. N. Martin. The work of revision has been carried out by Messrs. G. B. Howes and D. H. Scott, of the Normal School of Science. Besides other improvements, including the addition of the Earthworm and the Snail in the series of animal, and of *Spirogyra* in the series of vegetable, types, the order of the subjects is completely changed. Whereas in the original edition the lowest forms of life were first dealt with, and then the rest in ascending scale, the course is now reversed, beginning with the Frog and proceeding thence to the less familiar regions of invertebrate organizations until the border-land between animals and plants is reached, and a natural ascent can be made to the most complicated vegetable organisms. Prof. Huxley explains in the preface to the new edition that after two or three years' trial of the road from the simple to the complex he became thoroughly convinced that the way from the known to the unknown was easier for students.

AN exhibition embracing every branch of science or manufacture connected with the art of photography will be opened at the Crystal Palace in February next. Valuable exhibits have already been promised, and there is every reason to believe that the collection of pictures and apparatus will be larger than at any previous exhibition, while the classification will be far more complete. Medals and certificates will be awarded for competitive photographic lantern slide entertainments.

WE are informed that the Committee appointed by the Pari Academy of Medicine to investigate the influence of fluorhydric acid on tuberculosis has reported very favourably on the subject. It seems that the Bacilli of tuberculosis are speedily destroyed by minimal proportions of fluorhydric vapours. This fact is an important one for the therapeutics of that very common and fatal disease, tuberculosis.

THE additions to the Zoological Society's Gardens during the past week include a Common Wolf (*Canis lupus*), European, presented by Mr. C. S. Hardy; a Spotted Crake (*Porzana maruetta*), British, presented by Mr. F. W. Proger; two Golden Plovers (*Charadrius pluvialis*), British, purchased.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *DECEMBER* 25–31.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on December 25

Sun rises, 8h. 7m.; souths, 12h. 0m. 14·9s.; sets, 15h. 53m.: right asc. on meridian, 18h. 15·0m.; decl. 23° 24′ S. Sidereal Time at Sunset, 22h. 8m.

Moon (Full on December 30, 8h.) rises, 13h. 32m.; souths, 20h. 31m.; sets, 3h. 41m.*: right asc. on meridian, 2h. 46·7m.; decl. 10° 40′ N.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° ′
Mercury..	7 5 ...	11 0 ...	14 55 ...	17 15·1 ...	23 8 S.
Venus.....	4 3 ...	8 51 ...	13 39 ...	15 5·2 ...	14 32 S.
Mars......	0 30 ...	6 24 ...	12 18 ...	12 38·2 ...	1 54 S.
Jupiter....	4 57 ...	9 22 ...	13 47 ...	15 36·5 ...	18 28 S.
Saturn....	18 29* ...	2 18 ...	10 7 ...	8 31·1 ...	19 23 N.
Uranus...	1 16 ...	6 49 ...	12 22 ...	13 3·3 ...	6 2 S.
Neptune..	13 47 ...	21 27 ...	5 7* ...	3 43·6 ...	17 59 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich).

Dec.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.	
			h. m.	h. m.	°	°
27 ...	75 Tauri ...	... 6 ...	18 26 ...	19 35 ...	55	274
27 ...	B.A.C. 1391 ...	5 ...	20 8	near approach	352	—
29 ...	119 Tauri...	... 5½ ...	2 3	near approach	41	—
29 ...	68 Orionis	... 6 ...	17 58	near approach	148	—
31 ...	B.A.C. 2683 ...	6 ...	18 37	near approach	141	—

Dec.	h.	
26 ...	8 ...	Mars at greatest distance from the Sun.

Variable Stars.

Star.	R.A.	Decl.			
	h. m.	° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	Dec. 26,	23 24	*m*
			,, 31,	23 3	*m*
Algol	3 0·8 ...	40 31 N. ...	,, 29,	1 17	*m*
			,, 31,	22 6	*m*
λ Tauri...	3 54·4 ...	12 10 N. ...	,, 26,	20 39	*m*
			,, 30,	19 31	*m*
S Tauri	4 23·0 ...	9 42 N. ...	,, 31,		*M*
ζ Geminorum ...	6 57·4 ...	20 44 N. ...	,, 30,	2 0	*m*
R Canis Majoris...	7 14·3 ...	16 11 S. ...	,, 25,	21 54	*m*
			,, 27,	1 10	*m*
U Canis Minoris...	7 35·2 ...	8 39 N. ...	,, 28,		*M*
W Virginis	13 20·2 ...	2 48 S. ...	,, 30,	21 0	*M*
R Hydræ	13 23·6 ...	22 42 S. ...	,, 29,		*M*
V Boötis	14 25·2 ...	39 23 N. ...	,, 31,		*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 25,	5 20	*m*
R Draconis	16 32·4 ...	67 0 N. ...	,, 29,		*M*
β Lyræ...	18 45·9 ...	33 14 N. ...	,, 27,	18 0	*M*
U Cygni	20 16·1 ...	47 32 N. ...	,, 29,		*M*
V Cygni	20 37·6 ...	47 44 N. ...	,, 31,		*M*
Y Cygni	20 46·6 ...	34 10 N. ...	,, 26,	21 39	*m*
			,, 29,	21 32	*m*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 26,	20 0	*m*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
	°	°	
Near δ Aurigæ... ...	92 ...	56 N. ...	Slow; bright.
,, ζ Ursæ Majoris.	200 ...	57 N. ...	Slow.

THE U.S. COMMISSION OF AGRICULTURE.[1]

"Resolved by the Senate and House of Representatives of the United States of America, in Congress assembled, That there be printed 310,000 copies of the Annual Report of the Commissioner of Agriculture for the year 1885; 200,000 for the use of the Members of the House of Representatives, 80,000 for the use of the Members of the Senate, and 30,000 copies for the use of the Department of Agriculture.

"Sec. 2. That the sum of 200,000 dollars is hereby appropriated out of money in the Treasury to defray the cost of the publication of the said Report."

If the British Government desires to assist poor languishing agriculture, it would be well for it to look across the Atlantic Ocean for suggestions as to possible action. A "Commissioner of Agriculture" and an Annual Report from him is in itself enough to arrest attention. The very gilt letters on the back of this volume supply a text upon which a profitable and edifying sermon might be preached. The subject-matter of the Report, its practical or unpractical nature, the sort of topics handled, and the manner of their handling, all ought to arouse curiosity in the minds of those who doubt the utility of Commissions, and prefer *laissez faire* to stirring up with the long pole.

A more scattered flock than the agriculturists of Great Britain it would be difficult to find. Sheep without a shepherd, soldiers without a leader, a fleet without sailing orders, are the metaphors we should use if it were our purpose to portray their present condition. It is not so in America. There the interests of agriculture are watched by a Department of Agriculture, and the splendid Report of the proceedings of this Department serves as a mouth-piece of the whole agricultural community, and exercises the functions of a heart in keeping up a healthy circulation of knowledge and a brain in receiving impressions from all parts of the body agricultural. No wave of pleasurable sensation arising from salubrity of climate or rise of values but causes a smiling paragraph. No twinge of pain caused by insect attack or disease but is at once chronicled and investigated in this excellent Department. The cost is all defrayed by the Government, who are not afraid to spend 200,000 dollars on the mere publication of the Report. Whether the Report is worth the immense sums of money that its material with the large staff of persons employed in collecting the same must have cost is a question of much importance, and not altogether easy to answer. One thing, however, we may be certain of: that if it pays the American Government to undertake the investigation of problems connected with the productive powers of Nature, still more would it pay us with our complicated agriculture and extensive system of cultivation. It might be said in extenuation of our supineness with regard to agricultural science that we have an Agricultural Department of the Privy Council. So far as this Department may prove a nucleus for further expansion it is good, but we cannot conceal from ourselves the narrowness of the scope of our Agricultural Department as compared with the breadth of the aims and objects of the American Agricultural Department. The energies of our Department are chiefly devoted to what is included in the Report before us as the Bureau of Animal Industry, but with this great difference: the English Agricultural Department deals chiefly with inspecting and regulating the ports of debarkation, reporting on outbreaks, and proclaiming infected districts. It is intimately connected with and assisted by the police. The American Bureau of Animal Industry deals in rules and regulations for the suppression and extirpation of contagious diseases, but in addition spends large sums upon investigations into the nature, causes, and remedies of diseases. Its Reports are replete with information as to liquid cultures of the Bacterium of swine fever and other diseases. The American Government have not only set themselves the task of preventing the spread of disease, but are doing excellent work in tracking diseases of all sorts to their source, with a fair and improving prospect of being able to stop their devastations at the fountain-head. Not only is this the case with regard to the diseases of animals, but also of plants, under the sections respectively headed "Report of the Botanist" and "Report of the Microscopist."

Before endeavouring to lay before the readers of Nature any of the facts recorded in this deeply interesting volume, I will mention the various sections under which information is collected and investigations are prosecuted, feeling confident that by so doing I shall show the many sides from which agriculture obtains direct assistance from the progress of pure science. First in order stands the Report of the Superintendent of Gardens and Grounds, containing valuable information upon mildews and blights, the peach-leaf blister, cracking of pears, and the potato-disease. Next comes the Report of the Chief of the Seed Division, dealing with crossing and hybridization, the production of new varieties of wheat by cross-fecundation, improvement by selec-

[1] "Report of the Commission of Agriculture, 1885." (Washington Government Printing-Office.)

tion and cultivation, vitality of seeds, germination of seeds, and changing seed. The Report of the Botanist consists in an illustrated descriptive list of certain economic plants, and a chapter upon the fungous diseases of plants. Next comes the Report of the Microscopist, dealing with textile fibres, parasites of domestic fowls, crystals of fats—butter, beef, and lard—beautifully illustrated with coloured plates, and highly interesting in connection with the adulteration of butter. I must content myself with a mere enumeration of the Reports of the Chemist, the Chief of Division of Forestry, the Entomologist, the Statistician, the Chief of the Bureau of Animal Industry, a Report on wheat-culture in India, and truck-farming, "or the growing at the South, exclusively for the Northern markets, as a distinct business, of all (or a selection of) such fruit and vegetables as would be likely to arrive at their destination in good condition."

Before concluding this first notice, I must mention the fine manner in which the work is illustrated by tables, diagrams, maps, engravings, and coloured plates. The illustrations of fat-crystals have been already mentioned. Other illustrations are a delicately-tinted and beautifully-drawn collection of twelve edible mushrooms common in the United States; a coloured picture of the transformation of *Cicada septemdecim*, taking place in every stage, on a leafy branch of oak; and splendidly-executed coloured plates illustrative of verminous bronchitis and of ulcerated cæcum in the Section of Animal Industries.

To an Englishman, probably the most interesting portion of the book will be the Report of the Statistician, with its tables of exports and imports, area, and productive power of the United States. The control which the States exercise over the wheat trade of the world is indicated by a diagram showing that, as the yield per acre of the States rises, the prices of wheat all over the world fall; and as the average yield diminishes the prices rise. This correspondence between yield and price is even more precise in the case of oats and maize than in the case of wheat, because, as the Statistician remarks, "we make our own prices for corn and oats, while Liverpool has much to do with the price of wheat."

A very striking diagram, which cannot fail to be of deep interest to those who feel themselves cramped for room in overcrowded England, is one showing the proportion of forests, farms, and unimproved or waste lands in the United States. The vast and almost appalling extent of the first and last sections shows the inexhaustible resources of the country. In Texas, California, Dakota, Montana, New Mexico, Arizona, Nevada, Colorado, Wyoming, Oregon, Idaho, Utah, Kansas, Minnesota, Nebraska, and even Washington, the amount of cultivated or farmed land is quite insignificant compared with the vast tracts of forest and of unreclaimed land. One cannot but reflect upon the fact that a country so wealthy in the raw material of the soil should yet find it advisable to spend money lavishly upon scientific investigation of agricultural difficulties, while England, with her restricted area and dense population, should allow her agriculture to drift, as though its welfare were of no importance, or its downfall no cause of anxiety.

JOHN WRIGHTSON.

WEIGHTS AND MEASURES.

THE Annual Report of the Standards Department of the Board of Trade on its proceedings and business during the past year has been recently issued. It would appear that the Department has of late been pressingly engaged on ordinary work under the several Acts of Parliament which govern its proceedings, but there are some matters of scientific interest referred to in the Report to which we might invite attention.

Standards of various kinds, for determining capacity, length, weight, and volume, continue to be verified for official purposes, or for private use in aid of scientific research or otherwise, without fee or any charge.

Further representations have been made as to the want of a standard hydrometer, accurately adjusted to the legal units of weight and measure in force in this country, for determining the specific gravities of liquids heavier than alcohol.

The sanction of the Treasury has been obtained to the purchase, at an estimated cost of £1000, of copies of the new metric standards of length and weight, which are being prepared at Paris, under the directions of the Comité International des Poids et Mesures.

An exhaustive series of comparisons of the geodetic standards of New South Wales with those of the Board of Trade and the Ordnance Survey has been made by Mr. H. C. Russell, Government Astronomer, Sydney, and Mr. H. J. Chaney, of the Standards Department; of which comparisons a separate Report has been prepared.

In a memorandum on the accurate definition of metrological units, which is attached to the Report, it is pointed out, with regard to metric units, that the relation of the metric unit of weight, the kilogramme, to the metric units of length and capacity is not based on a natural constant, as is generally taught. If the kilogramme prototype were lost, for instance, it would not be restored by reference to the weight of water contained in the cubic-decimetre. The latest experiments have shown that the cubic-decimetre of distilled water ($t = 4°$ C.) weighs, under given conditions, nearly 100 milligrammes less than a true kilogramme weighs. Hence the value of the unit of capacity, the litre, depends on the kilogramme weight, and not on the metre measure. There is *de facto*, it is stated, no more scientific relation between the metric unit of weight, the kilogramme, and the metric units of length and capacity, the metre and litre, than there is between the present conventional metre and the original natural standard of one ten-millionth part of the Paris meridian.

It is curious to note, session after session, how large an amount of purely technical work continues to be added to the ordinary duties of local officers such as inspectors of weights and measures, inspectors of gas, inspectors of petroleum, &c. During the past year we notice, for instance, that the Legislature has, amongst other things, made it necessary for all weighing-machines used at mines in determining colliers' wages, as well as machines used in weighing cattle to be examined and tested by the local inspectors, many of whom are simply constabulary officers. Now the testing of a compound lever weighing-machine requires some special knowledge, but many of the officers have, it would appear, no technical qualification whatever for such duty. Hence the duties imposed by the Legislature are in many districts carried out in an indifferent and perfunctory manner; and another practical instance is afforded of the necessity for increased technical education of that class from which the above local officers are drawn. Without requiring, as in Germany, that every such local officer—as an inspector of weighing-machines—should pass a technical examination, it would certainly appear to be desirable before such officer is appointed that the local authorities (as the County Justices and Town Councils) should see that he has had some proper scientific training.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The term has been very uneventful so far as the Natural Science School is concerned. There has been no new departure in scientific education, and no important conflict with the rest of the University. The most satisfactory feature of the term is the granting of £1200 to be expended during the next three years on the Pitt-Rivers Anthropological Museum. The collection has been enriched by the transference of a quantity of valuable objects from the Ashmolean Museum, and by private gifts; the arrangement and cataloguing of the whole collection is proceeding steadily under the superintendence of Mr. Balfour of Trinity.

Unfortunately Prof. Moseley's continued illness has made it necessary for him to apply for prolonged leave of absence. Dr. S. J. Hickson, Downing College, Cambridge, will act as his deputy next term.

The Millard Laboratory for Experimental Mechanics at Trinity is to be enlarged during the vacation by the addition of a lecture-room and drawing-room, which formed part of Mr. Bosanquet's Laboratory at St. John's.

CAMBRIDGE.—At the annual election of candidates not yet in residence, the following awards were made:—

Foundation Scholarships: H. H. Hough (£80, in Mathematics), St. Paul's School; A. G. Pickford (£60, in Mathematics and Physics), the Owens College, Manchester; E. F. Gedye (£50, in Mathematics), Leys School, Cambridge. Minor Scholarships: F. A. Leete (£50, in Mathematics), Wellingborough School; C. Robertson (£50, in Mathematics), Norwich School. Exhibitions: E. W. MacBride (£50, in Natural Science), Queen's College, Belfast; V. M. Turnbull (£33 6*s.* 8*d.*, in Mathematics), St. Bee's School. Sizarships: A. W. Cuff, in Natural Science; R. E. Baker, in Natural Science; W. N. Maw and G. F. J. Rosenberg, in Mathematics.

SCIENTIFIC SERIALS.

THE *Quarterly Journal of Microscopical Science* for November 1887 (volume xxviii. part 2) contains the following papers:—On the development of *Peripatus novæ-zealandiæ*, by Lilian Sheldon, Bathurst Student, Newnham College, Cambridge. (Plates 12 to 16.) The ripe ova are large when compared to those of *P. capensis* or *P. edwardsii*, measuring about 1·5 mm. in their long axis; this size seems due to the enormous amount of food-yolk with which the eggs are charged; the segmentation is on the centrolecithal type; the protoplasm is in the form of a reticulum; there are no traces of cell outlines. The various stages, from a want of material, were not in all cases noted, but the authoress with great ability traces many stages of the development of the embryo, until that in which the food material is completely absorbed, so that the embryo lies just within the vitelline membrane and egg shell. We trust that she will continue her investigations as fresh specimens are obtained, until she is enabled to write the whole life-history of this very interesting form.—On some points in the anatomy of Polychæta, by J. T. Cunningham. (Plates 17 to 19.) This paper gives the results of some investigations into certain Polychæte structures; on the nephridia and gonads, with a criticism of Cosmovici's paper on the "Glandes genitales et Organes segmentaires des Annelides Polychetes"; on the cardiac body, and on the neural canals.—On Temnocephala, an aberrant monogenetic Trematode, by William A. Haswell. (Plates 20 to 22.) Four species were found; one, *Temn. novæ-zealandiæ*, found on *Paranephrops setosus*, from rivers of New Zealand; a second, *Temn. minor*, on *Astacopsis bicarinatus*, from streams of New South Wales; a third, *Temn. quadricornis*, on *Astacopsis franklinii*, from northern rivers of Tasmania; and a fourth, *Temn. fasciata*, on *Astacopsis serratus*, streams of New South Wales. Diagnoses of these species are not given, but it is possible to distinguish them by the comparative details given of their structure; they seem to differ from the type species of the genus, *T. chilensis*, Gay; and Wood-Mason is probably wrong in thinking that this latter species is to be found in New Zealand. When undisturbed, the Temnocephala adhere to the surface of the crayfish by means of a sucker.—Notes on Echinoderm morphology, No. xi.: on the development of the apical plates in *Amphiura squamata*, by Dr. P. Herbert Carpenter, F.R.S.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 8.—"The Post-embryonic Development of *Julus terrestris*." By F. G. Heathcote, M.A. Communicated by Adam Sedgwick, F.R.S.

With regard to the development of the cœlom and generative organs, I have obtained the following results. The somites divide into two parts, as described for *Strongylosoma* by Metschnikoff, one part remaining in the body and the other part projecting into the legs. The cavities in these two parts together constitute the cœlom. The part within the legs breaks up and the cells give rise to muscles. The part within the body passes dorsalwards along the thin sheet of mesoblast which unites it to its fellow of the other side, so that the two vesicle-like parts meet above the nerve-cord in the middle line. They join so as to form a single tube, the generative tube. The young ova, as well as the follicle cells surrounding them, are formed by cells proliferated from the walls of this generative tube. The body parts of the somites of the antennæ and mandibles break up and disappear, but those of the third pair of appendages give rise to the pair of salivary glands. There are two pairs of somites to each double segment.

In the development of the nerve-system, I find that there are two cerebral grooves formed as in *Peripatus*. They disappear early in the development. The ventral nerve-system, which at first consists of two separate cords united by a thin median part, undergoes a process of concentration which results in the presence of a single stout cord showing slight traces of its former double condition.

The heart is formed from mesoblast cells in the body-cavity. These cells, which were directly derived from the hypoblast in the early stages of development, form a network in the body-cavity. The heart is the result of a joining together of the meshes of this network, and thus is formed by the confluence of a series of spaces in the mesoblast, and has nothing to do with the development of the cœlom.

The body-cavity is a series of spaces between the gut and the body-wall, and is divided up by the mesoblast cells already referred to. It is distinct from the cœlomic cavities of the somites, and is therefore a pseudocœle.

The eye-spots are all formed in the same manner. The hypodermis thickens, and a cavity appears within it bounded by pigment. This cavity becomes a distinct vesicle. The front wall of the vesicle becomes very thin and furnishes the lens, while the cells of the back (*i.e.* most internal) wall and sides become elongated and form the retinal elements of the eye. The nuclei of the front wall become very faint and finally disappear.

The most striking feature of the development is the reduction of the ventral part of the young animal and the increase of the dorsal. In the just hatched animal the ventral region is nearly as large as the dorsal, and the legs are wide apart, having a distinct space between them. As development progresses the dorsal region is increased, while the ventral is contracted till the bases of the legs are close together. The corresponding concentration of the nerve-cord I have already mentioned. In a paper on *Euphoberia*, a Carboniferous Myriapod, Mr. Scudder points out that one of the principal points in which the genus differs from existing Diplopoda is the development of the ventral region. The relations of the dorsal and ventral regions of the body of the *Euphoberia* correspond exactly to the condition of the young *Julus*.

With regard to the double segments of *Julus*, Newport held that each double segment corresponded to two segments originally distinct which had fused together; subsequent writers have held that each double segment is a single segment which has developed a second pair of legs. Now considering the double segments with regard to the development as well as to the adult condition, we see that the mesoblastic segmentation is double, so are the tracheal, the nervous, and circulatory systems. The only part of these double segments which is single is the dorsal plate with its stink glands which arise as invaginations in it; this dorsal plate being so enlarged as to form a complete ring round the body of the adult. Looking at the palæontology, we find that in the Archipolypoda, a family including the Archidesmidæ, Euphoberidæ, and Archijulidæ, the dorsal plate did show distinct traces of a division. Therefore I think that each double segment represents two complete segments, the dorsal plates of which have fused together to make one plate.

Zoological Society, December 6.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Howard Saunders exhibited (on behalf of the Rev. H. A. Macpherson) a specimen of the Isabelline Chat (*Saxicola isabellina*) shot in Cumberland, being the first recorded occurrence of this species in Great Britain.—Prof. Bell exhibited and made remarks on specimens of the tegumentary glands from the head of the Rocky Mountain Goat (*Haplocerus montanus*).—A communication was read from Prof. H. H. Giglioli and Count T. Salvadori, containing notes on the fauna of Corea and the adjoining coast of Manchuria. The notes were founded on a large collection, principally of Vertebrates, made by order of H.R.H. Prince Thomas of Savoy, Duke of Genoa, whilst he was in command of the *Vettor Pisani*, on a voyage round the world, 1878–81. The collection was stated to be now deposited in the Royal Zoological Museum at Florence.—A communication was read from M. L. Taczanowski, containing a list of birds collected in Corea by M. J. Kalinowski between September 1885 and March 1887. A Woodpecker in the collection was considered to be new to science, and named *Thriponax kalinowskii*.—Prof. W. H. Flower read a paper on the Pygmy Hippopotamus of Liberia (*Hippopotamus liberiensis*), and its claims to distinct generic rank. The specimen of this animal in the National Collection possessed two incisor teeth on one side of the lower jaw. This and other considerations induced the author to question the advisability of separating it generically from *Hippopotamus*.—Mr. Francis Day, communicated a paper by Mr. J. Douglas-Ogilby, of the Australian Museum, Sydney, on a new genus and species of Australian Mugilidæ, which he proposed to designate *Trachystoma multidens*.—Mr. Day also read a second paper by Mr. Ogilby, giving the description of a new genus of Percidæ based on examples taken in the Gulf. of St. Vincent, South Australia, which the author proposed to describe as *Chthamalopteryx melbournensis*.—A communication was read from Dr. M. Menzbier, of Moscow, describing a third

species of Caucasian Wild Goat. This he proposed to call *Capra severtzovi*, being the *C. caucasica* of Dinnik, but not of Guldenstaedt.—Mr. Blanford read some critical notes on the nomenclature of Indian Mammals, in which he treated of *Macacus ferox*, Shaw (*M. silenus*, auct., *nec* Linn.), *M. irus*, Cuv. (*M. cynomolgus*, auct., *nec* Linn.), *M. rhesus*, *Presbytes thersites* Blyth, *Semnopithecus chrysogaster*, *Felis bengalensis*, *F. jerdoni*, *Herpestes mungo* (*H. griseus*, auct., *nec* Geoffr.), *Vulpes vulgaris*, *V. alopex*, and the genera *Putorius*, *Mustela*, *Xantharpyia*, *Cynonycteris*, *Hipposiderus*, and *Phyllorhina*.

Geological Society, December 7.—Prof. J. W. Judd, F.R.S., President, in the chair.—The following communications were read:—A letter from H.M. Secretary of State for the Colonies, inclosing an account of recent discoveries of gold in the Transvaal.—On the age of the altered limestone of Strath, Skye, by Dr. Archibald Geikie, F.R.S. The remarkable alteration of the limestone of Strath into a white saccharoid marble, first described by Macculloch, has hitherto been regarded as an instance of contact-metamorphism in a rock of Liassic age. The various writers who have described the geology of the district have followed Macculloch in classing the whole of the ordinary and altered limestone with the Secondary series of the Inner Hebrides. The author, however, saw reason in 1861 to suspect that some part of the limestone must be of the age of the Durness Limestone of Sutherland—that is, Lower Silurian; and he expressed this suspicion in a joint paper by the late Sir R. I. Murchison and himself, published in the eighteenth volume of the Quarterly Journal of the Society. He has recently returned to the subject, and now offers lithological, stratigraphical, and palæontological evidence that the altered limestone is not Lias, but Lower Silurian. In lithological characters the limestone, where not immediately affected by the intrusion of the eruptive rocks, closely resembles the well-known limestones of the west of Sutherland and Rosshire. It is not more altered than Palæozoic limestones usually are. It contains abundant black chert concretions and nodules, which project from the weathered surfaces of the rock exactly as they do at Durness. These cherts do not occur in any of the undoubted Lias limestones of the shore-sections. The limestone lies in beds, which, however, are not nearly so distinct as those of the Lias, and have none of the interstratifications of dark sandy shale, so conspicuous in the true Liassic series. The stratigraphy of the altered limestone likewise marks it off from the Lias. There appears to be a lower group of dark limestones full of black cherts, and a higher group of white limestones with little or no chert, which may be compared with the two lower groups of the Durness Limestone. A further point of connection between the rocks of the two localities is the occurrence of white quartzite in association with the limestone at several places in Strath, and of representatives of the well-known "fucoid beds" at Ord, in Sleat. These latter strata form a persistent band between the base of the limestone and the top of the quartzite, which may be traced all the way from the extreme north of Sutherland southward into Skye. Palæontological evidence confirms and completes the proof that the limestone is of Lower Silurian age. The author has obtained from the limestone of Ben Suardal, near Broadford, a number of fossils which are specifically identical with those in the Durness Limestone, and so closely resemble them in lithological aspect that the whole might be believed to have come from the same crag. Among the fossils are species of Cyclonema, Murchisonia, Maclurea, Orthoceras, and Piloceras. The relations of the limestones containing these fossils to the other rocks were traced by the author. He showed that the Lias rests upon the Silurian limestone with a strong unconformability, and contains at its base a coarse breccia or conglomerate, chiefly composed of pieces of Silurian limestone, with fragments of chert and quartzite. The metamorphism for which Strath has been so long noted is confined to the Silurian limestone, and has been produced by the intrusion of large bosses of granophyre (Macculloch's "syenite") belonging to the younger, or Tertiary series of igneous rocks. After the reading of the paper some remarks were made by Mr. Etheridge, Dr. Hicks, Mr. Marr, Dr. Hinde, and Mr. Bauerman. In thanking the Fellows for the reception they had given to his paper, Dr. Geikie said that a preliminary sketch of the results of the recent work of the Geological Survey in the north-west of Scotland would, he hoped, be presented to the Society early next year.—On the discovery of Trilobites in the Upper Green (Cambrian) Slates of the Penrhyn Quarry, Bethesda, near Bangor, North Wales, by Dr. Henry Woodward, F.R.S.—On *Thecospondylus daviesi*, Seeley, with some remarks on the classification of the Dinosauria, by Prof. H. G. Seeley, F.R.S.

Entomological Society, December 7.—Dr. David Sharp, President, in the chair.—Mr. Jenner-Weir exhibited, and made remarks on, twelve specimens of *Cicadetta hæmatoides*, collected last summer in the New Forest by Mr. C. Gulliver.—Mr. McLachlan exhibited a specimen of *Pterostichus madidus*, F., which he had recently found in a potato. It seemed questionable whether the beetle had been bred in the cavity or had entered it for predaceous purposes. Mr. Theodore Wood, Mr. Kirby, and Mr. Herbert Cox took part in the discussion.—Mr. McLachlan also exhibited two specimens of a species of Trichoptera—*Neuronia clathrata*, Kol.—which occurred rarely in Burnt Wood, Staffordshire, and elsewhere in the Midlands. On inquiry he was informed that the two specimens exhibited had been found in the Tottenham Marshes.—Mr. Porritt exhibited a series of *Cidaria russata*, from Yorkshire, the Isle of Man, the Hebrides, and the south of England. The specimens from the two first-named localities were almost black.—Mr. Verrall exhibited a specimen of *Mycetæa hirta*, Marsh., which was found devouring a champagne-cork. The Rev. Canon Fowler remarked that certain *Cryptophagi* had the same habit. The discussion was continued by Mr. McLachlan, Mr. Jenner-Weir, and Dr. Sharp.—Canon Fowler exhibited specimens of *Acronycta alni* and *Leiocampa dictæa*, which came to the electric light on Lincoln Cathedral during the Jubilee illuminations. He also exhibited a specimen of *Harpalus melancholicus*, Dej.—Mr. Billups exhibited, for Mr. Bignell, an interesting collection of British oak-galls. He also exhibited the cocoon and pupa-case of a South American moth, from which he had bred 140 specimens of a species of Ichneumonidæ.—Mr. O. Janson exhibited, for Mr. C. B. Mitford, a collection of Lepidoptera from Sierra Leone.—Mr. White exhibited a curious structure formed by white ants at Akyab.—Mr. Waterhouse exhibited a series of diagrams of the wings of insects, and read notes of observations on the homologies of the veins—a subject to which he had given especial attention for some time past. Mr. Champion, Mr. Verrall, Mr. McLachlan, Dr. Sharp, and Mr. Poulton took part in the discussion which ensued.—Mr. G. T. Baker contributed descriptions of new species of Lepidoptera from Algiers.—Mr. Gervase F. Mathew communicated a paper entitled "Life-histories of Rhopalocera from the Australian Region." The paper was accompanied by elaborate coloured drawings of the perfect insects, their larvæ and pupæ.—Mr. F. Merrifield read a report of progress in pedigree moth-breeding, with observations on incidental points. Mr. Francis Galton alluded to the close attention Mr. Merrifield had given to the subject, and complimented him on the neatness, ingenuity, and skill with which his experiments had been conducted, and on the results he had obtained therefrom. Mr. Poulton, Dr. Sharp, Prof. Meldola, and others continued the discussion.

Chemical Society, December 1.—Mr. William Crookes, F.R.S., President, in the chair.—The following papers were read:—The alleged existence of a second nitroethane, by W. R. Dunstan and T. S. Dymond.—An extension of Mendeléeff's theory of solution to the discussion of the electrical conductivity of aqueous solutions, by Holland Crompton.—Note on electrolytic conduction and on evidence of a change in the constitution of water, by Henry E. Armstrong.—Bismuth iodide and bismuth fluoride, by B. S. Gott and M. M. Pattison Muir.—The action of hydrogen sulphide on arsenic acid, by B. Branner, Ph.D., and F. Tomicek.—Note on the constitution of mairogallol, by C. S. S. Webster.

PARIS.

Academy of Sciences, December 12.—M. Janssen in the chair.—On the law of errors of observation, by M. J. Bertrand. Two propositions are affirmed: first, that, if a given magnitude be repeatedly measured, and the measures grouped by twos in haphazard order, by selecting in each group the greatest of the two errors committed the relation of the mean of the squares of these greatest errors to the mean of the squares of all the errors will converge towards the value $1 + \frac{2}{\pi}$, when the number of essays increases indefinitely; second, if the measures be similarly grouped in threes, the mean of the squares of the

greatest errors in each group divided by the mean of the squares of all the errors has for probable value $1 + \frac{2\sqrt{3}}{\pi}$, and approaches indefinitely towards this value according as the number of essays is increased.—Comparison of the various systems of electric synchronization for astronomical clocks, by M. C. Wolf. These remarks are made in reference to M. Cornu's recent communication on a new process of synchronizing time-pieces. The various systems hitherto employed for this purpose are passed in review, and their respective merits and defects are studied with exclusive reference to their suitability for employment for synchronizing time in observatories, towns, &c.—On the various modes of explosive decomposition of picric acid and the nitric compounds, by M. Berthelot. This inquiry, instituted in consequence of the doubts recently raised regarding the property of picric acid to explode by heating alone, throws much light on the various modes of decomposition of the nitric compounds properly so called, showing how these various modes depend on the initial temperature of the decomposition.—Remarks in connection with the presentation of a work entitled "Collection des anciens Alchimistes Grecs," by M. Berthelot. This "Collection," just issued by M. Berthelot with the co-operation of the Greek scholar, M. Ch. E. Ruelle, embodies much information regarding the origin of alchemy, the precursor of the modern science of chemistry. Compiled from unedited Greek manuscripts scattered over the public libraries of Europe, it comprises about 400 pages of Greek texts dating from the Alexandrine and Byzantine periods, and mostly anterior to the writers who stimulated chemical studies in the West. Amongst the treatises here for the first time edited are those of the pseudo-Democritus, of Synesius, and Olympiodorus, with French translation, copious notes and commentaries. In the introduction of 300 pages is embodied much information on the mystic relations of metals and planets, on the spheres of astrologists, on the old chemical signs and notations here reproduced by the photogravure process, the whole forming a sequel to the author's work "Sur les Origines de l'Alchimie," presented to the Academy two years ago.—On the application of photography to meteorology, by M. J. Janssen. These remarks are made in connection with the presentation of a series of large photographs which were taken on the Pic du Midi last October with a view to recording meteorological phenomena by the photographic process. The series comprises four views of the section of the Pyrenees within the horizon of the Peak at sunrise just before the solar rays have affected the almost continuous mass of clouds stretching from the Atlantic to the eastern part of the Pyrenees, filling all the valleys and enshrouding all but the highest summits of the range. Other photographs exhibit these clouds when acted on by the early rays of the luminary, and converted into the semblance of a storm-tossed sea. Images were also taken of the remarkable effects observed at sunset, and the satisfactory results of this first essay made it evident that photography may be applied with great advantage to the study of atmospheric phenomena.—Researches on the theory of the figure of the planets, by M. O. Callandreau. These researches, forming a second contribution to the study of the planets, are devoted more especially to the larger members of the solar system, in which the extent of flattening of the poles is an element which cannot be neglected in the general calculation.—On the compressibility of the solution of ethylamine in water, by M. F. Isambert. The experiments here described confirm the conclusions already arrived at by the author, showing that the aqueous solutions of the ammoniacal bases must be regarded as true chemical combinations, more or less dissociated, and dissolved in an excess of water.—On the geographical distribution of the Actiniæ inhabiting the French Mediterranean waters, by M. P. Fischer. A list is given of the thirty-three species already determined on the south coast of France. Of these sixteen are found also on the French Atlantic coast, which comprises twenty-four species not yet discovered in the Mediterranean. The northern limits of the French species have been clearly determined, but not so the southern, several forms occurring also in the Red Sea, and on the North and West African seaboards.

STOCKHOLM.

Royal Academy of Sciences, December 14.—Considerations on some theories of atmospheric electricity, by Prof. Edlund.—On the displacement of the shore line along the coasts of Sweden, by Dr. L. Holmström.—An account of the cosmological theory of Mr. Norman Lockyer, and of the views of Nordenskiöld on the subject, by Prof. Baron Nordenskiöld.—On post Glacial deposits containing *Ancylus fluviatilis*, by H. Munthe.—On *Rubus corylifolius*, Arrh., and *Rubus pruinosus*, Arrh., their nomenclature and value as species, by Dr. L. M. Neuman.—On the hyperborean fir, *Pinus silvestris*, L., *b. lapponica*, by Hr. Th. Örtenbladt.—On the development of the primary bundles of vessels of the Monocotyledons, by Miss S. Andersson.—On oyster-culture in Bohus, by Count Ehrensvörd.—On mutations in the coefficient of elasticity of the metals in consequence of the transmission of a galvanic current, by Dr. Mebius.—On conduction of electricity between flames and points, by K. Asperén.—On the influence of temperature on the exponent of refraction and the density of rock-salt, by Miss N. Lagerborg.—On a recent form of the Echinoconidæ, by Prof. S. Lovén.—On the forms of the fruit of *Trapa natans*, L., which formerly existed in Sweden, by Prof. Nathorst.—On the morphology and development of the Pantopoda, by Dr. G. Adlerz.—Contribution to the knowledge of the carbon-hydrates, by Drs. C. Johansson and Ekstrand.—On the action of fuming sulphuric acid on α-naphthalin combined with carbon-hydratic acid, by R. Manzelius.—On the action of sulphuric acid on α-nitro-naphthalin, by W. Palmær.—Analytical researches on the air near the fortress of Waxholm, in October 1885, by Dr. A. E. Selander.—On systems of coincidence of common algebraic differential equations, by Dr. J. Möller.—On some algebraic analogies conducting to elliptic integrals, by Dr. A. M. Johansson.—The conditions for an algebraic analogy,

$$y^n = (x-a)^{m^1} \ldots\ldots (x-a)^{m^r},$$

to lead to elliptic integrals, by the same.—On the wave-length of algebraic curves, by G. Kobb.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Gospel Ethnology: S. R. Pattison (Religious Tract Society).—Tenants of an Old Farm: Dr. H. C. McCook (Hodder and Stoughton).—The Gospel in Nature: Dr. H. C. McCook (Hodder and Stoughton)—British Dogs, Nos. 13 and 14: H. Dalziel (U. Gill).—Proceedings of the Birmingham Philosophical Society, vol. v. part 2 (Cornish, Birmingham).—A Critique of Kant: K. Fischer; translated by W. S. Hough (Sonnenschein).—Circulars of Information of the Bureau of Education, No. 1, 1887 (Washington).—The Study of History in American Colleges and Universities: H. B. Adams (Washington).—Des Mortiers Hydrauliques: M. H. Le Chatelier (Dunod, Paris.

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